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R I C K E T S

ILLUSTRATED BY NUMEROUS CASES AND SOME

SPECIAL PHOTOGRAPHS.

Being a  
THESIS FOR THE DEGREE OF DOCTOR OF MEDICINE  
OF THE UNIVERSITY OF EDINBURGH

By

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# R I C K E T S.

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## I N T R O D U C T I O N.

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Modern medical science, aided by all the latest discoveries, and assisted by well equipped laboratories, has been spreading its tentacles over the wide world and grappled with the problems of disease of all races and of all climes. Schools of tropical medicine are rapidly becoming established, and, under their auspices, expeditions have been formed to endeavour to cope with and, if possible, destroy the causes of malaria, sleeping sickness, yellow fever, and other diseases imperfectly understood at present, and likely to be so until our knowledge concerning their protean manifestations has been advanced by prospective research. Their beneficial results are known to all, and their achievements duly applauded; but meanwhile there still remain, even at home, widespread diseases whose names are commonplace expressions, which take their toll of infant lives, year by year; so that, until some vigorous crusade is started throughout the land, when people awake to the significance of the wastage of infant life, and the deformity and physical enfeeblement of the children, these modern evils are likely to remain in our midst.

Many great problems are to be faced in our own country; and the greatest of them all is the terrible mortality among infants, under one year of age, that goes on, year by year, unchecked and undiminished by the improved conditions of living introduced by science and preventive medicine. The adult death-rate has been reduced by modern medicine and hygiene; but they appear to have in no way affected the rate of infantile mortality.

We are face to face with the fact that, although the general death-rate is decreasing, the infantile mortality is not declining (Newman, - Infantile Mortality). In 1905, the death-rate of infants in England and Wales was 120,000, which equalled one-quarter of all the deaths in that year. This about equals the population of Birkenhead. Imagine this town, wiped out by disaster, or decimated by a widespread epidemic causing 120,000 deaths; in other words, concentrate this loss of life, and immediately public feeling would be aroused, the press would be stirred, every effort would be made to discover the cause, and steps would be taken to avert, if possible, a similar calamity in the future!

Yet, because this loss of life is spread over a wide area of space and time, it has been allowed to go on for fifty years, sapping the nation's newborn



strength and depriving it of a population which would be useful to it in future generations. In all branches of science and medicine the last half-century can point to wonderful achievements: yet, when we read that the infantile mortality is almost stationary, surely a feeling almost akin to shame must sweep over us!

Decennial Death-Rate of England and Wales,  
for Adults and Infants, and the Birth-Rate.

	Birth-Rate per 1000.	Death-Rate per 1000.	Infant Mortal- ity per 1000.
1851 - 60	34.1	22.2	154
1861 - 70	35.2	22.5	154
1871 - 80	35.4	21.4	149
1881 - 90	32.5	19.1	142
1891 - 00	29.9	18.2	154
1901 - 05	28.4	16.0	138

The birth-rate has also been decreasing (4 births to every 1000 inhabitants), so that it is even more necessary that we should endeavour to safeguard the infants, and, if possible, help them through early life, in order that they may grow up healthy adults and useful citizens.

The greatest infantile death-rate is in the first three months of life; but many of the surviving children who are tided over this critical period grow up weakly, immature, and prone to disease, - so that they are scarcely able to withstand the trials of the first year of their existence.

In the last three quarters of the first year, many diseases can be traced to the carelessness and ignorance of the parents, who expose themselves and their infants unduly to cold, and pay little attention to their proper feeding; so that the majority of deaths can be attributed to gastro-intestinal disorders - e.g., diarrhoea, as well as disease of the respiratory organs, atrophy, malnutrition, scurvy, marasmus, rickets, and convulsions. If the child should survive, it may be left weak and puny; and, although in the early months of life it is not possible to make accurate diagnosis, the initial illness in reality may have been the forerunner or the first indefinite symptoms of rickets, which, if not treated, progresses, and still further wrecks the constitution of the child, distorts its limbs, and leaves it sadly handicapped in its future struggle for existence.

But, if rickets is a danger to the growing infant, in later life also it may lead to evil consequences, although the disease itself has completely disappeared from the system. There may be left some permanent shortening of the bones, with deformity of the skeleton, and distortion of the limbs, - so that the child is dwarfed in stature, and stunted in its growth.

The permanent teeth may suffer equally with those of the first dentition, leading to early decay, malformation of the jaws, and various disorders of digestion. The presence of bow-legs, knock-knee, and flat-foot may interfere considerably with locomotion, and seriously handicap the individual in competitions for various appointments, or prevent him obtaining employment in the mills or factories in his locality. Furthermore, there may be even permanent mental enfeeblement, and the child makes slow progress with its education. In the case of the female, the dangers of child-bearing are

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much increased, both for the mother and child, - so that even in the next generation it is possible to discern the evil effects of rickets.

It has been asserted by some authorities that the disease can be transmitted from parent to child, and therefore, if hereditary or constitutional taint exist, it should be eradicated at the earliest possible moment.

A disease, with so widespread an influence for evil consequences in the growing infant and in adult life, with such insidious and diverse symptoms, leaving behind so serious a tendency to various catarrhs and nervous instability, requires to be dealt with as speedily and effectively as possible with all the means in our power; and no pains should be spared to employ any remedy that can help in its thorough eradication.

The treatment should commence with the pregnant mother: her health should be supervised during gestation, she should be encouraged by all available inducements to suckle her own child and educated to understand and appreciate the manifold dangers of artificial feeding. Further, the health of the mother during lactation must be attended to with every care; and, when necessary, free meals might be provided for women with suckling infants, on the lines so wisely instituted in the city of Paris. The factory laws should be amended, and no woman allowed to work in the later months of pregnancy; and the interval after the confinement, before return to work is permitted, should be increased, if it is possible without interfering with the finances of the home. The early notification of the birth of infants should be insisted upon by all municipalities.

Expeditions are sent out to Africa, Egypt, the Gold Coast, etc., in order to investigate tropical diseases; house-to-house inspections are made; pits are filled up; pools are drained or covered with paraffin; and by these means, as well as by vigorous sanitation, disease is checked and lessened in large areas where before it was rampant.

In our own country it is not possible to attack a widespread disease like rickets in some similar manner; for systematic bands of workers, sanitary inspectors, lady visitors, and medical men, to keep in regular touch with the mothers, and, if possible, supervise the infants from the day of birth before ignorance and evil influences have done lasting harm!

The importance of fresh air and sunlight, as well as of cleanliness, must be insisted upon, and the mothers educated, by advice or leaflets, to the due recognition of the urgent necessity of feeding their infants at the breast.

The feeding of a child with farinaceous foods during the first few months of life should be prohibited by law, unless sanctioned by medical men. The infants during the first year of life should be weighed and inspected at regular intervals, and the mothers encouraged, in every possible way, to interest themselves in their proper welfare. If artificial feeding becomes a necessity, the mothers should be trained in the simple methods of using cow's milk with ordinary diluents, and as to the details required to be observed to prevent the contamination of the milk or the

bottles; or, without difficulty or extra expense, they should be able to obtain a supply of clean milk from municipal depôts or certified dairies.

By widespread organisations, only, will the nation be able to check the terrible mortality amongst infants, and help to rear for itself an imperial race. If such means were adopted, in the process of time, rickets might become a rare disease.

In the course of this thesis it is proposed to inquire, on these broad lines, into the etiology of rickets, and also to discuss the best means to be adopted to prevent and treat the disease.

## D E F I N I T I O N .

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Rickets is a chronic disease of nutrition, occurring during infant or early life, insidious in its onset, slow in development and slow in recovery, though very amenable to appropriate treatment. Its early symptoms are indefinite, attacking principally the nervous system, and the various organs of the body engaged in the processes of digestion and assimilation of food; its final and most definite signs are to be found in the osseous system, where it is readily detected owing to the bending and the deformities of the bones.

It is an affection that causes a peculiar retardation of development, as evidenced by late dentition, inability to walk, and slowness in learning to talk. These signs of defective development may continue after the period of infancy is passed, and so draw attention to the presence of the disease.

It is important to define rickets as a disease of malnutrition; and it should not be classified among the diseases of the osseous system, as this obscures the real nature of the affection.

The distortion of the bones of the head, thorax, and extremities, though often the most apparent signs of the disease, are only a small part of the true clinical picture; and, in order to be able to treat rickets intelligently, and at the earliest possible date, the other signs of depraved nutrition, - such as sweating of the head, restlessness, delayed dentition, and the various digestive and nervous disturbances, - should be carefully noted, in order that the child may be thoroughly inspected, and the defects in its diet or hygienic surroundings corrected with the least possible delay.

## S Y N O N Y M S      A N D      N O M E N C L A T U R E .

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Rickets - Rachitis - Morbus Anglicus - Chastre - Articuli Duplicati - Rachitisme - Nouures - Doppelte Gleider - Rachitismus.

The vernacular term in French is "Chastre", derived from "castrum", and is suggested by the deprivation of liberty caused by the disease. Sometimes the common people speak of "Nouures" (knottings), - owing to the distortion of the limbs, - and refer to rickety infants as "enfants nouures".

The common expression in Germany is "doppelte gleider" or "double-jointed".

The derivation of the word "Rickets" is referred to more particularly under the section on History.



## H I S T O R Y .

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Rickets is almost a disease of modern times, and had appeared much more in all countries since the women have left their homes to work in mills and factories, feeding their infants at the breast in an irregular fashion, or adopting the practice of artificial feeding - one of the curses of civilization. In olden days they worked at their spinning-wheels or at domestic duties at their own homes, and tenderly nurtured their infants; nowadays, however, they follow their husbands to the mills, with the result that the child must be placed out to nurse or left in a crèche and deprived of its natural sustenance. New customs, new diseases, etc., all bring in their train reports, books, conferences, and histories.

The history of rickets does not date back farther than the middle of the seventeenth century, when a disease appeared in the south-western counties of England, - especially in Dorset and Somerset, - and spread gradually over the whole country. A commission of eight members was appointed to inquire into the disease, and their report, published in 1650 by Glisson and others, is the first authentic account we have of the disease.

For a long time rickets was known as "morbus Anglicus" - the name coming into general use, not because the malady was more common in England than on the continent, but because the designation was used in a treatise published by Whistler, at Leyden in 1645, and entitled "De Morbo puerili Anglorum". D. Norman Moore (Trans. Path. Soc., 1881, Vol. xxxii) considers that Whistler had no right to be regarded as the discoverer of rickets, as his only claim to this honour rests on his assertion that he published a thesis in 1645, called "Paedospianchnosteocace", of which there is no trace; and, as he appropriated the funds of the College of Physicians, while their president, his own statement should be regarded as of little value.

Glisson was at work on rickets in 1645, and published a book in 1650. He attributed the prevalence of rickets in the south to the more luxurious habits of these communities, which nowadays reads somewhat curiously, as the disease is now regarded as more particularly affecting the poor. He first proposed the term "rachitis", as indicating one of the principal parts of the body attacked (rachis, a spine), and also because the sound of the word resembled the vernacular of the people.

The word "rickets" has been variously derived by different authorities. The true derivation is probably from "wrikken", an old English verb meaning to wrest or twist awry - the twisted and distorted limbs suggesting to the mind a comparison with "rickety" or delapidated furniture. It has also been derived from a Dorset word "rucket", to breathe laboriously; and also from "rick", an elevation or hump, as in Hayrick (Fagge). As the disease first appeared in these parts, possibly the name also may have originated out of



local terms. Trousseau gives the derivation from a Norman word "riquets", applied to deformed persons, and suggested by the name "Alberiquet", diminutive of "Alberic", a dwarf of Gothic mythology.

In the mortality of bills of London, rickets first appeared in the returns of 1634, there being 14 deaths. In 1658 - 59, there were 476 and 441 deaths respectively, the increase probably being due to the disease being better known to observers.

In 1660, Mayo, of Oxford, called attention to the softening of the bones; in 1741, Petit emphasized the evils resulting from early weaning; and, in 1751, Duverney described the pathological anatomy and showed that the bones were fragile, rarefied, and with a tendency to fracture under the slightest violence. Portal (1797) classified the disease as syphilitic, scrofulous, scorbutic, rheumatic, and as arising from intestinal disorders or following exanthems.

Guerin (1834) first suggested the classification now most commonly adopted:

- (1) Period of incubation and effusion.
- (2) Period of deformity.
- (3) Period of resorption, consolidation, and eburnation.
- (4) Period of consumption.

He also gave the name of spongioid tissue to the red reticulated tissue of the rickety bone.

Trousseau (1849) and others drew attention to the resemblance of rickets to osteomalacia; and Broca (1852) showed that rickets was an arrest of normal bone-development, and described the histological conditions.

Amongst later workers are Virchow, Kassowitz, - who strongly held the theory that rickets is inflammatory in origin, - and Parrot, who, in 1881, contended that rickets was only a form of congenital rickets, which statement was refuted by Comby and most British authorities.

In 1895, Sir Willian Jenner published his classical lectures on rickets, which are largely quoted from by most modern writers.

Sir William Barlow - writing on craniotabes and scurvy - and Cheadle are the principal authorities on this disease at the present day: the latter was perhaps the first to insist that rickets is a dietetic disorder in which the principal error is a deficiency of fat in the food of the infant.

## E T I O L O G Y.

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### AGE AND SEX.

Rickets is a disease of infancy; it is most common between 6 months and 2 years, and seldom seen after the child attains 3 years of age. It is an affection coincident with the period of the first dentition.

Ashby considers that, in its most typical form, rickets occurs between 6 months and 2 years; but early symptoms may be noted in the latter half of the first year (Ency. Med.).

Comby (Twentieth Century Practice of Med.) states that rickets commences about the tenth to the twelfth month, and may arise as late as two years, but is rare after three years. Out of 1662 patients examined, 1268 were between one and two years; and Pini, out of 4176 cases, found 2974 children two years of age.

Girls are supposed to be more prone to rickets than boys; but an examination of 200 cases by Comby (loc. cit.) did not confirm this statement. Most authorities have found that the sexes are almost equally affected.

Dr. Hall of Leeds, who examined a great number of school-children, writes that "rickets appears to be more common among the girls than the boys. The rickety dwarf, with bow-legs, narrow pelvis, and big head is no very uncommon object among girls but rare among boys" (Dr. Young's evidence, Phys. Deterioration Report, p. 89).

Goodhart (Diseases of Children, 12th Edn.) and Still give the following analysis of 141 cases:

Months.										Years.					
5	7	8	9	10	11	12	18	2-2½	3-3½	4	5	6			
3	1	3	2	5	6	11	36	26	19	13	2	6	5	3	

Gee (St. Barth. Hosp. Rep., Vol. iv, p. 69), in 635 cases, finds 365 boys and 270 girls. Of these

32	were under 6 months.
144	from 6 - 12 "
183	" 12 - 18 "
133	" 18 months to 2 years.
116	" the third year.
27	" " fourth "

He is of the opinion that 30 per cent. of sick children under the age of two years are rickety. The dates given by Dr. Gee indicate the time when the child was first brought to hospital, so that probably the onset of the disease was even earlier in the child's life. The large proportion of the cases are from the period of weaning and through the process of dentition.

Starr states that rickets may begin in intra-uterine life; but Vincent doubts if there is any foetal condition to which the term rickets may be applied.

Hutchinson (Dis. of Children) is doubtful if definite signs of rickets are often observed under the age of six months, and considers that the most likely time for it to come under observation is at about

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eighteen months of age, though it may begin earlier; and many good observers assert that it is diagnosable in the second six months of life.

Jacobi (Arch. Ped., 1902) considers that rickets often manifests itself at a very early stage, entirely in the muscles; and he regards obstinate constipation, beginning in the second or third month of life, as a sign of the disease. He applies this rule even to breast-fed babies, not constipated at birth, but becoming so in the second or third month of life.

Chance (Bodily Deformities, - Chance and Poland) has long entertained the opinion that rickets originates during intrauterine life "whilst development is going on, and while the basis of the osseous tissue is being laid down, and its constitution given to it". He emphasizes the fact that rachitic children always have bad teeth; and he believes that this is due to some original (constitutional) cause, and not merely imperfect nutriment subsequent to birth. He kept a register of 600 cases, and noticed that two-thirds of the number appeared in the first year, which he holds as proof that rickets is a disease of infancy, and that the cause must originate immediately after birth, or more probably is the persistence of a congenital disease. He compares his table with that of Guérin, and finds that both, in the main, are in agreement that the vast majority of cases of rachitis occur under two years of age. In his experience, 472 out of 600 were observed within the first year of life: out of this number 204, or one-third of the whole, before six months; and 108 were noticed by the mothers within the first month of life, and they maintained, as a rule, that the children were born with the disease. There are a few cases in this register between two and five years of age; and the tables, "in his judgment", support the opinion that rickets is always a congenital disease, arrested for a time, and revived again, a few months after birth.

Though rickets may not be evident in an infant before the end of the first year, it is advisable that minor symptoms should be carefully searched for at a much earlier period, in order, if possible, to arrest the insidious advance of the disease before the later effects - such as malnutrition, backward development, or deformities - have made their appearance and permanently disabled or distorted the child.

#### HEREDITY.

In a disease, the causation of which is, as in the case of rickets, so obscure, it is very natural that observers should endeavour to discover some clue from the influence of heredity. And, at times, parents who have suffered from rickets in childhood or in adult life show evidences of rickety deformities, beget children also with rickets, the possibility of some constitutional hereditary weakness handed down from parent to child is still further strengthened. At the present time but few authorities incline to the belief that heredity plays a part in the production of rickets, the more general opinion being that, if both the parent and the child have suffered from rickets, the cause must be looked for in an unhealthy environment - e.g., impure air, cold, want of sunlight; or that there had been some errors in the diet during infancy leading,



in each case, to the same disease.

Ashby (Diseases of Children) alludes to the difficulty of obtaining a trustworthy history from the parents of their infant's life, for in the absence of deformities, it is not always possible to discover if they have suffered from the disease. Heredity cannot be a constant factor, for the children of healthy parents become rickety, and, as a rule, the parents of rickety children show no signs of having suffered from this disease.

Pfeiffer believes that the tendency to rickets is hereditary, and assigns this as a predisposing cause, with the deficiency of phosphates in breast-milk as the initial excitant.

Vögel says that he knows many families, in which the parents - who showed signs of previously having had the affection - had children who all became rachitic, in spite of every precaution.

Sir William Jenner is doubtful whether impairment of the father's health has a tendency to cause rickets in the offspring; but Ritter v. Rittershain believes that he could trace it to the presence of tuberculous disease in the father, more often than in the mother. But the more general rule is that it is not the germ of a constitutional disease that is inherited, but rather similar unhygienic habits acting upon the parent and on the child.

The influence of heredity receives some support in the occurrence of congenital rickets (Comby), though Vincent (Nutrition of Infants) doubts whether any condition exists to which the term foetal rickets could be applied. Alcoholism, syphilis, tuberculosis, or any disease producing cachectic conditions in the parents would diminish the child's resisting-power and predispose to rickets (Holt). But any of the causes might also impair the milk of the mother, or her debility may cause inability to suckle the infant, and consequent resort to artificial means; and therefore, though the development of rickets in the child may be attributed to the ill-health of the mother, in reality the true cause would be found in the evil conditions resulting from improper food, unhealthy environment, or inability to suckle the child at the breast. If, on the other hand, the father had suffered from rickets or cachectic dyscrasia, the infant may have inherited a weakened constitution with some inability to readily assimilate its food, - so that these conditions will predispose to the development of rickets. Indeed, it is only in a modified way that we can regard hereditary influences as playing a part in the production of this disease.

Out of 4176 cases examined, Pini found 52 apparently hereditary; in 86 there was consanguinity of parents, but, at the same time, he found other causes for the existence of the disease.

Sir Samuel Wilks (Trans. Path. Soc., Vol. xxxii) refers to a case of Dr. Ormerod's, in which a father, who had had rickets in childhood and mollities ossium in adult life, had also two daughters, who suffered severely from rickets. Though unable to state the condition of the mother or the management of the food, he thought there

was nothing improbable in the idea of the hereditary transmission of a constitutional tendency to rickets.

Sir William Jenner appears to have regarded rickets as a diathesis comparable to scrofula, tuberculosis, or congenital syphilis, though Fagge and Eustace Smith do not agree with him in the matter.

F. Siegert (Jahr.f.Kinderh., Dec., 1903) has studied the question for ten years, and strongly believes in the hereditary nature of rickets. He gives four tables in support of this view:

Table I.- Thirty-one families in which breast-fed babies had rickets, ~~with the~~ exception of one case, the mother had had rickets, or showed signs of the disease - such as deformity of the skull, chest, bow-legs, or difficult labour. In one case the father had had rickets, but not the mother. The children, though entirely breast-fed, had severe and protracted rickets.

Table II.- Twelve families with no history of rickets in the parents, and the children breast-fed. These children showed no evidence of rickets: none had delayed dentition, or were late in walking.

Table III.- Twelve families: none of the parents had had rickets, but some of the children suffered from the disease. The causes of rickets were artificial feeding, disease of the respiratory tract, and the age or illegitimacy of parents.

Table IV.- Fourteen families in which the parents had rickets, and the children were fed artificially. The rickets in the last set of cases developed earlier than in breast-fed babies, dentition was later; and the disease ran a more chronic course, with a higher mortality. The most severe forms of rickets appeared in breast-fed babies with rachitic parents. The death-rate of 121 artificially-fed rachitic infants was 57 per cent., ~~and~~ of breast-fed rachitic infants 36 per cent., and of breast-fed babies immune to the disease 15 per cent.

Siegert concludes that heredity is one of the most important etiological factors of rickets, which disease is generally transmitted through the mother. Diseases of the digestive and respiratory tracts, and the moral conditions of the parents, he places next in importance to heredity.

Chance (Bodily Deformities, Edited by Poland) is fully assured that rickets is unquestionably hereditary, and that the morbid taint passes direct from the parent to the ovum, and influences every stage of its development. He is of the opinion that many cases, apparently originating during infancy, are congenital ones, in which the disease, for a time, has lain dormant, and that, as soon as the infant is deprived of its mother's milk and subjected to the evil influences of improper diet, and the advent of the irritation of teething, the disease lights up again in the tissues and attacks the skeleton, the true germ of the disease, however, being implanted in intrauterine life. He cites the case of a foetus, showing signs of rickets, referred to by Jamplin (On the Nature and Treatment of Deformities), who states that, though he has been unable to trace the history of the parents, no doubt exists in his mind of the disease being hereditary.

Cheadle, however, considers that rickets dies out with childhood, and is not likely to be transmitted.



Despite the fact that some authorities seem to show that the influence of heredity in the causation of rickets is effectual, the balance of evidence inclines to support the theory that rickets is not an hereditary disease, but that weakly parents, or parents who have had rickets in infancy, tend to have delicate offspring, and thus beget rickety children.

### FOOD.

An investigation into the etiology of rickets soon convinces the inquirer that most of the theories promulgated fail to supply evidence sufficiently strong to warrant the claim that one cause alone is at work in the production of the disease.

Climate, especially cold and temperate regions, bad air, ill-ventilated dwellings, want of sunlight, heredity, syphilis, or constitutional disease, want of lime in the drinking-water or in the tissues of the body, and excess of lactic acid in the blood, - may all predispose, but none alone are able to cause the appearance of rickets in the growing infant.

It is natural, therefore, to turn to diet, and to inquire if any error in the food has an adverse influence on the health of the child, which, if persisted in, may result in rickets. It is necessary to examine the natural food of the infant, and to note whether the fault lies in some want of balance of the food constituents, or if excess of food, or underfeeding, is acting adversely upon the health of the child.

The natural food of the infant is its mother's milk; it is at once evident that it is important to discover whether the infant at the breast is liable to rickets, and what alterations in the maternal milk may result in the appearance of the disease. The growing disinclination of mothers to suckle their infants and the tendency to go out to work too soon after the birth of the child, are referred to by Hutchinson and Cheadle as some of the causes of the increase of rickets in modern times; they undoubtedly are largely accountable for the great and stationary infantile mortality during the last fifty years.

As the infant is often deprived of its natural sustenance and fed by artificial means, it is equally important to inquire of the use of these substitutes for cow's milk (condensed milk or patent foods) are more liable to cause rickets, and what alterations in the food, or defect in their nutritive value, is productive of so widespread an evil as the rachitic dyscrasia.

The standard of the healthy diet for the developing infant must be taken as good human milk; any dietetic substitute should possess the same elements in the appropriate proportions.

Before proceeding further, it will be advisable to state the constituents of human milk, and then to examine its separate elements, endeavouring at the same time to discover what variations injuriously affect the child, and with special reference to this disease.

Though human milk varies in its constitution, the average analysis, according to Hutchinson (Food and

Dietetics), is as follows:

Proteid .....	1.5	per cent.
Fat .....	3.5	" "
Lactine .....	6.5	" "
Mineral salts .....	0.2	" "
Other constituents .....	0.6	" "
Water .....	87.7	" "

Johanassen analysed the milk of twenty-five women, twenty to forty-six years of age, primiparae and multiparae, with healthy infants, and during the first to the third months of nursing. His findings were:

Proteids .....	0.06 - 2	per cent.
Fat .....	0.63 - 6.65	" "
Milk and sugar .....	2.55 - 9.77	" "

The milk of primiparae is richer in sugar, proteids, and fat; blondes, and women poorly nourished - especially with excess of starchy food - yield a milk poor in proteids. Human milk is richer in fat between twenty and twenty-five years of age; richer in proteids between twenty-five and thirty; and richer in sugar about thirty.

The first point that is very strikingly apparent, when one examines into the bearing that diet may have on this disease, is that all authorities agree that breast-fed infants seldom suffer from rickets up to the period when weaning should take place. Therefore, as a food, the normal breast-milk of a healthy mother may be regarded as little likely to produce rickets in a healthy infant.

Comby considers that one of the reasons why rickets is unknown in China, Japan, and India is the almost universal practice of breast-feeding. In Japan, 99 per cent. of the infants are breast-fed (Infantile Mortality Report); and, though often kept at the breast for some years, are given fat or oil as an additional food (C. Allbutt, - Syst. of Med., Vol., iii).

Spencer Watson (Trans. Path. Soc., 1891) collected evidence from several physicians in India and Burma. They were unanimous in stating that rickets was to be regarded as a rare disease and seldom seen, though there was a possibility that many children died of opium-poisoning through drugging before the disease developed. The practice of mothers suckling their infants is almost universal, and there is little overcrowding, as the people live so much in the open air. Even if the breast-fed infant is affected by rickets, the type of the disease is less severe.

Premature infants, or those who are reared with difficulty, or who have suffered from diarrhoea, and gastric or bronchial catarrh, are liable to suffer from rickets. Disorders of digestion, flatulence, vomiting, diarrhoea, though often the precursors of rickets, are not always present. Many children with no preliminary disorder of digestion become rickety, while, on the other hand, others who may have suffered severely show no signs of the disease. If, with vomiting and diarrhoea, there is a lack of power to assimilate food, rickets may supervene on malnutrition. Starvation causes atrophy and not rickets: overfeeding with unsuitable food is more likely to cause the disease.

After the first year of life, the protection of the breast-fed infant against rickets is not so pronounced. The maternal milk deteriorates in quality, and the malnutrition of the child soon begins to suffer. It is possible also that the prolonged drain of nursing has told upon the health of the mother, who is now unable to supply to the infant the proper proportion of the elements of food, with the ferments and antitoxins, which have been its safeguards against infection during the early months of life. Pregnancy during lactation also seems to affect adversely the breast-fed infant and to lead to rickets.

In spite of abundance of good maternal milk, rickets occasionally occurs in breast-fed infants; but, as a general rule, the statement, advanced by Cheadle, may be accepted, - that rickets occurs in breast-fed children only when the mother is sickly and feeble, or has suckled the child into the second year, and the milk has thus deteriorated in quality.

Adrianse (Arch. Ped., 1903) combats the prevailing idea that breast-fed babies never become rickety, and asserts that it is no uncommon thing to see these infants with a mild type of rickets, more especially cranial rickets. This is difficult to explain, unless it is that the milk contains a deficiency of bone-forming elements. He considers that a deficiency of proteids and salts predisposes to rickets, though due regard must be paid to many other etiological factors. He gives but little attention to the possible deficiency of fat, and expressly states that it is the quality of the proteids which gives information concerning the functional activity of the milk; he cautions against taking the amount of fat as a guide for estimating the true value of milk as a food for an infant.

The breasts of the nursing mother, with little effort, are able to secrete fat and sugar, but, in the later months, proteid is only produced in small amounts. The milk of prolonged lactation is deficient in salts and proteids, and the latter will be very low when lactation is about to cease at any date in the period of nursing, unless under emergency or inability to use the breasts.

During the entire period of lactation the percentage of fat in human milk is extremely irregular, but that of the proteids remains almost constant until the approach of the time for weaning the child, when it falls rapidly. By the end of the eighth month, it is below 1 per cent. The salts of the milk are intimately associated with the proteid, and also show gradual decrease during the progress of lactation.

Cases of rickets have been reported as due to excessive fat-feeding; and the writer suggests that a possible causation is a failure of the infant, in these cases, to absorb sufficient proteid. The proportion of the constituents of the milk must be kept at a normal level: otherwise disorders of malnutrition appear.

The proteid is necessary for life, for it is the only element capable of replacing the constant nitrogenous waste of the cells of the body, and any interference with provision of the due supply interferes with digestion and assimilation of food.



Though proteid alone can sustain life, it is greatly assisted by the addition of fat and carbohydrate to the food, in order that body-heat may be adequately maintained. Twenty-two parts of proteid can do the work of ten parts of fat, but only one-half or two-thirds as much proteid are required if fat and carbohydrate are also present (Munk, - Quoted by Holt). Proteid appears in the form of casein and albumin in milk; and it is important to note that the proportions differ in the milk of the cow and woman: According to Konig (Brit. Med. Jour., Sept. 1, 1903) these are as follows:

	Human.	Cow.
Casein .....	0.59	2.88
Albumin .....	1.23	6.53
Total proteids ..	1.82	3.41

Starvation of proteid causes backward development: the infant is weak in muscle, sitting up becomes delayed, and the child is late in crawling and in learning to stand and walk. The most constant symptom of insufficient proteid is anaemia. There will also be general feebleness, poor circulation, flabbiness of tissues, and failure of nutrition, with inability to digest the other elements of the food. The child is fretful, peevish, and irritable; and there is a frequent tendency to perspire about the head, and the fontanelles and sutures of the cranium are late in closing. These symptoms of malnutrition, due to lack of proteid, closely resemble a clinical picture of rickets; and it seems therefore advisable in the treatment of this disease to watch carefully that the child has sufficient proteid in its diet.

The salts are in a state of organic combination; the calcium and the phosphorus are combined with casein. Phosphorus is an active element in the cell, and is always present when growth is most active. Calcium is of importance, for it supplies the lime so necessary to bone-formation. A milk deficient in casein will be poor in calcium, phosphorus, and iron; therefore, such a food will predispose to rickets.

Human milk is also particularly rich in lecithin, an organic compound necessary for growth and repair of the nervous system.

A certain proportion of infants are fed at the breast, but, in addition, are given boiled bread, biscuits, or some form of farinaceous food. This class of patient is very difficult to deal with, for, if questioned about the feeding of the infant, the invariable reply is that the child is having the breast, and only persistent cross-examination reveals the fact that starchy food is given likewise. The mother usually resents any advice, and is supported in her method of feeding her infant by her grandmother, relatives, or interfering neighbours. But it is evident that some of these infants thrive better with the addition of well-boiled bread; and the bread-jelly of Cheadle is a valuable food in cases of diarrhoea, or when milk is badly tolerated by children. A large proportion of these mixed-fed children suffer from gastro-intestinal disturbances or convulsions.

The writer has failed to collect any trustworthy evidence whether infants fed on the breast with a small

addition of farinaceous food show frequent signs of rickets. He has at present under observation a child fed in this manner, who seems to show signs of rickets. The breast-feeding, however, is extremely irregular.

Case of Incipient Rickets. - October 16, 1906.

Baby Benton, aged 5½ months. Eighth child of the parents; mother nurse all but one; none dead. Patient has square head, open fontanelles, plenty of hair, slightly enlarged epiphyses, and is very restless at night when copious perspiration is observed. Navel projecting, legs wasted, and also bowed. A few patches of craniotabes. Weight: 10½ lbs. Breast-fed, but mother goes out to work, so that this feeding is irregular, and the child is left in a crèche where it has milk and water and Mellin's Food. Mother poorly nourished, has indigestion and constipation. Father has had leucoplakia of tongue, but does not own to a previous syphilis. For the last fortnight the baby has had diarrhoea, with light slimy motions and vomiting. Cries a great deal with colic. Slight bronchial catarrh. Ammoniacal urine. Treatment. - Regular feeding, every three hours if possible, at the breast, or a supplementation of same with the following mixture:

Cow's milk .....	1 part.	) Six ounces to be given every three hours.
Water .....	3 parts.	
Sugar .....	1 small lump.	
Lime-water ....	1 teaspoonful.	

R/

Hydrarg. c Creta, gr. ¼

Sig. - Night and morning for  
six doses.

October 23. - Child tranquil and digesting its food well. Weight 10¾ lbs. October 30. - Bowels regular. Weight 11½ lbs. Bronchitis disappearing. Breast three times a day. Milk mixture, as before, two bottles. The milk mixture continued, but directions given to increase the strength of the milk very gradually. Since this date the patient has passed from observation.

The largest proportion of cases of rickets seen in this country, either in hospital or in private practice, occur in the case of infants fed on cow's milk, condensed milk, or proprietary foods. Indeed, when due enquiry has been made into the surroundings and habits of the child, the flaw almost constantly present is injudicious artificial feeding.

Cheadle (Artif. Feeding, 6th Ed.) maintains that there is only one constant factor present in the causations of rickets - the food factor, and believes that all other conditions, - e.g., want of sunlight, bad air, and damp and insanitary surroundings, - merely assist by degrading the nutrition of the child, and are not always present, or necessary for the production of the disease. He has never seen a child, even in unhealthy surroundings, develop rickets, if properly fed and free from dietetic disturbances.

This may apply to the children in English towns, but it does not thoroughly explain the fact that the Italians and negroes transplanted from the warm to colder climates of America, and probably also to unhealthy homes, but living on their accustomed diet, invariably suffer from rickets.

Rickets is largely a disease of the poor, but it does occur amongst children living under the best



hygienic surroundings, who, as a rule, are fed by artificial means - more especially on patent foods, which are often rich in carbohydrates, and poorly supplied with fat and proteids.

The two elements deficient in the food of children who become rickety are animal fat and proteid; and there may also be a paucity of phosphate of lime. It has been shown already how essential the proteids are for cell-growth and the development of the child, and how symptoms similar to cranial rickets supervene if the percentage is reduced to a low level in maternal milk. It is the backbone of the food, a blood-former, a tissue-builder, and a tissue-repairer.

Fat is found present in the body, unchanged, as fat. The uses of fat are intimately associated with those of the proteid, for it possesses the property of saving nitrogenous waste, and thus allows the proteid to expend its entire energy on cell-production. Fat is a "proteid-sparer", and prevents this element being drawn upon to supply bodily heat; for, if the proteid is used for this purpose, the body suffers, and the child may develop anaemia and malnutrition. Fat also assists in bone-formation, probably by aiding the absorption from the intestines of inorganic salts - especially the earthy phosphates. On a milk diet, if fats are withheld or greatly reduced, these salts appear in great quantities in the faeces.

A child requires more fat than an adult in its daily diet. It is stated that a child, under one and a half years of age, requires thirty to forty-five grammes of fat and sixty to ninety grammes of carbohydrates - i. e., one to two (the proportion in milk); whereas an adult man (doing moderate work) requires fifty-six grammes of fat to five hundred grammes of carbohydrate, or one in nine only. The total required by the infant in twenty-four hours is thirty to forty grammes, and the grown man fifty-six grammes, - so that the infant requires from half to three-quarters as much fat in its food as an adult person (Landois and Stirling's Physiology, Vol. i). On the other hand, the child requires less starch.

	Proteid.	Fat.	Carbohydrate.
Child 1½ years .....	20-60	30-45	60-90
	gram.	gram.	gram.
Man (moderate work) ..	118	56	500
	gram.	gram.	gram.

The rates are:

Proteid to carbohydrate -

20 - 60 = 1 : 3 child.  
118 - 500 = 1 : 5 adult.

The proportion of elements suitable for an infant food is:

Proteid ..... 1.5 per cent.  
Fat ..... 3.5 " "  
Carbohydrate ..... 6.5 " "

These conditions are most perfectly fulfilled by the human milk.

In the report on "Physical Deterioration", all the medical witnesses agree that rickets is caused by defective digestion and improper feeding, especially with artificial foods. It is often not due to actual

want of food,- for there is frequently an abundance of the wrong sort,- but to a want of proper food. In other words, it is a question of quality, and not of quantity; and the production of rickets must be attributed to a special, and not to a general, fault of nutrition (Cheadle,- Art. Feeding).

The foods most usually employed, if breast-feeding is not resorted to, are:

- (1) Cow's milk diluted with water or gruels.
- (2) Condensed milk.
- (3) Milk with farinaceous foods.
- (4) Foods alone (including dried milks).

The food should conform to the standard of mother's milk, but this is seldom the case.

Cow's Milk.

Human Milk.

Proteid .....	3 per cent.	1.5 per cent.
Fat .....	4 " "	3.5 " "
Carbohydrate .....	5 " "	6.5 " "

Cow's milk is richer in proteid, but weaker in fat and sugar, than mother's milk. In order to reduce the excess of proteid, the cow's milk is given diluted with water; and sometimes cream and sugar are added to supply the deficient elements.

The mixtures of cow's milk and water, time-honoured in their employment, are:

Milk - 1 part, Water - 2 parts.

Milk and water - equal parts.

Milk - 2 parts, Water - 1 part.

This readjusts the proteid, but the fat is reduced below the standard. Hutchinson gives the following tabulation of proportions:

	<u>Proteid.</u>	<u>Fat.</u>	<u>Carb.</u>	<u>Hyd.</u>
Cow's milk undiluted .....	3	4	5	
Milk 1 Water 2 .....	1.0	1.3	1.6	
Milk 1 Water 1 .....	1.5	2	2.5	
Milk 2 Water 1 .....	2.2	2.6	3.3	

Though the fat is deficient in all these mixtures, many children thrive well on them, and are only made ill when the carbohydrate is added to the milk. Even then, at first the child grows fat, and is apparently thriving; but the body-fat formed is of poor quality, and the muscular tissue weak,- so that, sooner or later, symptoms of rickets appear. Unfortunately, it is only when the child fails to walk in due season, or if, when able, the bones bend beneath its weight, that the mother becomes alarmed and seeks medical advice.

Condensed milk is a valuable food in emergencies, but, if the use be too long continued, the child grows up weak, anaemic, fat, and flabby, with a tendency to suffer from bronchial catarrh. Condensed milk contains a large excess of sugar, and is deficient in the anti-scorbutic element. To reduce the sugar, it should be used very largely diluted; for a young infant, the proportion is one of milk to twenty-four of water. As a rule, the directions on the tin advise much stronger proportions. The following is taken from Hutchinson's work:

Analysis of Condensed Milk.

	Proteid.	Fat.	Carbohydrate.	
Sweetened .....	10	13	52	15 Milk sugar. 37 Cane sugar.
Unsweetened .....	9	11	15	Milk sugar.
Sweetened .....	1.2	1.6	6.5	
Milk 1 part, Water 7.				
Unsweetened .....	1.2	1.5	5.6	
Milk 1 part, Water 6.				

Hutchinson (Diseases of Children) gives the composition of condensed milk, diluted 1 : 24, as follows:

Nestlé's Milk	- 13 per cent.	Fat.
Proteid	- 2.0 per cent.	
Fat	- 1.6 "	"
Sugar	- 8.17 "	"

The digestibility of condensed milk lies in the free dilution; and, in cases where it is successful, the cow's milk was used in a strong mixture and given up as a failure before trying it in weaker strengths, which would probably have been tolerated by the infant. The amount of casein in diluted condensed milk-mixture is small, and the precipitate of casein, formed on the addition of acetic acid, about equals that of peptonised milk.

Hill (Practitioner, 1904) directs attention to the unreliability of the domestic teaspoon as a measure. It seldom measures exactly a drachm, and the amount taken varies considerably, if the spoon is dipped into the tin, or the milk carefully poured out until level with the edge of the spoon. He ascertained, by experiment, that the average teaspoon, holding two and a half drachms, if carefully dipped into the tin, may hold on withdrawal three drachms, and the larger teaspoon capacity, three drachms, may be made to contain four drachms; if the milk is poured into the spoon, and none adheres to its under surface, an average teaspoon holds two drachms.

Still's Analysis.Undiluted Milk.

	Proteid	Fat.	Sugar.
Average tea-spoon (three drachms)...	11	9-13	55 per cent.
Water 3 ounces	1.2	1-1.5	6
= 1 in 8.			

From these analysis it is evident that condensed milk is difficult to handle, and that an infant, fed on a mixture of this milk and water, will be receiving a food containing an excess of carbohydrates or a deficiency of fat.

It is impossible to construct a mixture that will conform to the standard of mother's milk.

Experiments with Animals.— Certain animals, under bad hygienic conditions or fed on unsuitable food, suffer from a disease that strongly resembles human rickets.

Dr. Crisp (Trans. Path. Soc., Vol. xxviii) exhibited bones of pheasants that had been confined in a small space and did not get natural food. The bones showed softening and distortion. He also remarked (ibid.) that London-bred poultry, inadequately supplied with proper food and air, often have deficiency of phosphate of



lime in their bones, which fact is evidenced by the bending of the sterna with permanent distortion.

Among young dogs, fed on large quantities of animal and vegetable food, rickets is not infrequent; and lambs, in cold bleak situations, are especially affected with the disease.

Guérin fed puppies for four or five months on meat, when they all showed signs of rickets; whereas, the remainder of the litter, which was still suckled by the mother, remained strong and healthy.

Tripier tried a repetition of this experiment, but substituted cats, dogs, and chickens for puppies: a;; the animals died on the meat-diet, but he was unable to produce rickets.

Dr. Baxter fed animals with starchy foods, and they all developed a condition of extreme marasmus from which the animals died without the development of the rachitic dyscrasia. The animals were fed upon a diet of pure arrow-root jelly, with a variable quantity of milk, and soon the starch passed through the intestines unchanged. There was speedily produced a condition of inanition; and the bones took part in the general atrophy, being thinner and frail, - but there were no rachitic changes at the epiphyses. Baxter (Trans. Path. Soc., Vol. xxxii) attributed his failure to produce rickets to the difficulty which he experienced in keeping the animals alive for a sufficient length of time to cause the disease. He is inclined to doubt whether all cases of so-called rickets in the lower animals are identical with the human disease.

At the Zoological Gardens (Regent's Park, London), many of the animals suffered from rickets; and the prevalence of the disease was attributed, by the keeper, to the clayey soil and cold locality. Bland Sutton, however, noticed that young monkeys, deprived of their mother's milk and fed upon vegetables, became rickety, and that young bears, on a diet of raw meat, rice, and biscuits, suffered from weakness with softening and bending of the bones, and, if the diet were persisted in, they died of extreme rickets. For ten years past, it had been impossible to rear the lion-whelps in these gardens, for they invariably died of rickets. They were given a diet of raw meat, very tough and deficient in fat, with old bones, devoid of marrow and so hard that the fullgrown lions were unable to crunch them - practically a starvation diet. Bland Sutton continued this food, but added milk, cod-liver oil, and pounded bones. In three months, all signs of rickets disappeared, and the whelps became healthy and strong. The only change made was in the food, - so that the theory, that the disease was caused by the soil and climate, was disproved: for the animals remained in the same cages, and the conditions of air, light, and warmth continued unaltered. The successful treatment of these animals, by diet alone, supports, in a very striking and remarkable manner, the theory that the deficiency of fat, and possibly also lack of proteids and lime salts, is the chief factor in the production of rickets.

Fat Starvation. - Dr. Herter, of New York, once endeavoured to produce rickets in pigs by fat starvation. A pig was fed, for fifty-one weeks, on a limited quantity of skim-milk containing one-fortieth per cent. of fat; the milk of the sow averages 8 - 10 per cent. fat, - so that the pig only received 1/300 to

1/400 of the normal amount of fat. At the end of the experiment, on this diet, the pig had gained sixteen pounds; its skin was dry, and it suffered from great debility, weakness, and constipation. Another pig, fed on an unlimited quantity of the same milk for twenty weeks, also developed muscular weakness and drowsiness. A third pig, fed for fifty-six weeks with skim-milk and carbohydrates, became very weak, and had occasional attacks of diarrhoea. Other pigs were also experimented on, but, at all the post-mortems, Hetter was unable to find any evidence of rickets, especially in the bones. The fat of the adipose tissue was replaced by mucoid degeneration; but this change was not found when the animals received the addition of carbohydrate to the milk. From the result of these experiments Herter concluded that fat starvation does not cause rickets.

That this is correct, in the case of pigs, seems fairly proved; but the case of the child, fed on skim-milk, that came under Dr. Cheadle's notice, affords strong evidence that fat starvation of a human infant tends to give rise to the disease. The child in question lived in the country, and, as the father was a coachman to a wealthy family, the parents were allowed an unlimited supply of milk. Plenty of milk was therefore obtainable, and the child appears to have digested it without difficulty. It, however, developed rickets; and inquiry showed that the milk was only skim-milk, from which all cream had been removed before presentation to the coachman. In addition to this skim-milk, the child was given farinaceous food, and so was fed upon a diet in which fat was almost absent. Readjustment of diet, with the addition of fat, cured the child of the disease.

The addition of fat to the diet of rickety children nearly always cures the malady, and often, too, without the aid of drugs or other treatment. If children who suffer from rickets are given cream or cod-liver oil with their food, they invariably improve - especially if proteid, in the form of raw meat-juice, is also added to the dietary.

Though it is not altogether to disregard the other factors at work in the causation of rickets; - such as heredity, cold, impure air, and want of sunlight, - it may be admitted that, as a general rule, the addition of fat to the diet - especially with the association of proteid - will cure the disease. Yet, it must be clearly borne in mind that there is some danger in feeding an infant on excessive fat. Administration of food with a high percentage of fat, if rapidly instituted or too prolonged, may set up indigestion, intoxication, and diminished absorption of fat, and thus produce rickets on a diet that was intended to be a preventive or cure.

Cream, more particularly dairy cream, frequently contains an excess of fatty acids, which may cause indigestion, malaise, or auto-intoxication. Milk with an excess of cream will give rise to gastritis, vomiting, diarrhoea with large and oily motions, or constipation with hard, dry, crumbling stools, full of fat, and also ammoniacal urine. The child wastes, and rickets may



supervene. The absorption of proteid is interfered with, and thus a second danger is introduced. Feeding with a high fat-percentage is particularly apt to occur with the cream and whey or top-milk mixtures, in use nowadays when the child is fed on modified cow's milk.

Holt (Arch. Ped., Jan., 1901) records four cases, two of which showed some signs of rickets (large fontanelle, craniotabes, late teething, tetany, and sweating of the head), whilst the third had convulsions, but no other signs of this disease.

Personal Observation.— In June, 1906, the writer observed a case, that of an infant feeding on a diet rich in cream, which caused vomiting, diarrhoea, and loss of weight. There was sweating of the head, slight craniotabes, large fontanelle, and kyphosis of the spine.

Baby Woods suffered from fat indigestion, and has been vomiting food for some weeks past. Has been given a strong mixture of milk and water, with cream added. There is also diarrhoea, and slimy stools. Child has kyphosis of the spine in the dorsal region, sweating of the head, and wide fontanelles. Weight 13 lbs., 2 ozs. Treatment.— Put on a weak mixture of milk (1 part) and water (3 parts). On the third day of July, the vomiting ceased entirely. Every two and a half or three hours a mixture of milk (8 parts) and barley-water (12 parts) was given, in doses of four ounces, a teaspoonful of maltine being also added. The dose was afterwards increased to five ounces. The weight slowly increased; but, as the child had an untrustworthy nurse, it was impossible to check the results of feeding. On September 9th, the infant weighed 15 lbs., 8 ozs.

CARBOHYDRATES.— Sugar and starches play an important part on the economy of the organism. They can be converted into fat, and are a source of animal heat; but they cannot restore nitrogenous waste, and take no part in the formation of cell tissue. Carbohydrates is present in the milk as lactose; starch is not a constituent of milk: it must be regarded as a foreign body, and as of no utility in the first stages of infancy. The ptyalin ferment is not present in the saliva until the second month of life; and the diastatic ferment does not appear in the pancreas until the end of the first year.

H. Shaw (Med. Ann., 1904) made a series of a hundred experiments, in order to test for the presence of a diastatic ferment in the stomach, and ptyalin in the saliva of infants, — the latter varying in ages from sixteen days to two months. He concluded that (1) the saliva of very young infants contains a diastatic enzyme capable of converting small amounts of starch into maltose; (2) that the diastatic action of the saliva may continue in the stomach for two hours after feeding; and (3) that, on physiological grounds, there is no reason why infants cannot digest small amounts of starch.

Starch and maltose, the main ingredients of most patent foods, are not found in the milk of any mammal; and, though infants often do well on barley or dextrinised gruels, it is possible that they possess

a mechanical, rather than a nutritive, value by assisting in the digestion or modification of the curd in the stomach. The best results are obtained if the amount of starch is small (0.7 per cent.); and the effect of the curd is lessened if the starch is converted into dextrine and maltose (F. White, - Milk Coagulation and Digestion).

A diet of carbohydrates may lead to rapid increase in weight; but the strength gained is not proportionate, and the muscular tissue is flabby. Infants thus fed have but feeble resistance, and many of them become rachitic (Holt). The easy digestion of a food consisting chiefly of carbohydrates, and the rapidity with which children gain weight are apt to mislead the parent or medical adviser. A diet with excess of carbohydrate, especially if weak in proteid and fat, if persisted in, will cause malnutrition. The pictures of fat babies, exhibited as posters to advertise patent foods, are apt to create a false impression that healthy infants can be reared by these means, though the child is really fat but unhealthy, and possibly suffers from rickets. A fat baby, the winner of the first prize at a baby-show, was soon afterwards treated, at the Great Ormond Street Hospital, by Dr. Cheadle for advanced rickets.

Carbohydrates appear in human milk as lactose, the amount usually being 6.5 - 7 per cent. The proportion of proteid to carbohydrate for a child is 1 : 3, and for an adult is 1 : 5; the fat to carbohydrates is in a child 1 : 1.9, and in adults 1 : 5. The infant requires more fat and less carbohydrate than the adult. This condition is not fulfilled by most of the patent foods, which show a great deficiency in fat.

Taking dried human milk as the standard, Hutchinson gives the following percentages of the subjoined and other foods:

	Fat.
Dried Human Milk .....	26.4 per cent.
Allenbury's No 2 .....	12.3 " "
Horlick's Malted Milk .....	9.0 " "
Mellin's Food .....	Trace.
Benger's Food .....	1.2 " "
Allenbury's No.3 .....	1.0 " "
Moseley's Food .....	0.92 " "
Neaves' Food .....	1.0 " "

Some of these foods are recommended to be made with milk (Mellin's, Benger's, Neaves'); others are intended to replace milk (Allenbury's No.1, Horlick's), and are usually dried preparations of cow's milk with modifications.

The following analyses are published by James Knight (Rep. of Conference on Infantile Mortality); the foods were made with a milk having the following composition:

Specific Gravity ....	1032
Proteid .....	3.6
Fat .....	4.0
Lactose .....	5.37

Neaves' Food.- Basis is oat flour. Free starch present.

	Proteid.	Fat.	Carbohydrate.
Dry Food .....	12.10	0.86	82.03 - %
With water .....	0.78	0.005	5.40 - %

The directions given for use with milk are vague in character.

Benger's Food.- Wheaten flour pancreatised. Free starch contains 48½ per cent. soluble matter.

	Dry Food.	Prepared: Milk 1, Water 2).
Proteid .....	12.48%	2.1%
Fat .....	0.86%	1.8%
Carbohydrate.	76.91%	6.2%

Frame's Food.- A biscuit flour with malt added.

	Dry.	Prepared (Milk 1, Water 2)
Proteid .....	19.86%	4.5%
Fat .....	Trace.	1.1%
Carbohydrate.	76.54%	14.49%

Mellin's Food.- Starch reduced almost to pure dextrine. For an infant of the age of three months, it is directed to use three level teaspoonfuls of food to eight tablespoonfuls of milk and water.

	Dry.	Made up for 3 Months.
Proteids .....	10.01	1.63
Fat .....	0.08	1.22
Carbohydrate .	78.86	5.36

Allenbury's Foods.- No. 2 contains milk and deposits fat on standing. Two-thirds of the food consists of carbohydrates - viz., milk-sugar ½, and milk-sugar and dextrine 9 %.

	Dry Food.	Made up.
Proteids (nitrogen) .	9.86%	1.71 %
Fat .....	15.04%	2.49%
Carbohydrates .....	68.85%	11.46%

Allenbury's No. 1 is a dried modified milk; and the same firm's No 3 is a malted food containing starch.

Patent foods are unable to replace cow's milk by approximating more closely to human milk: for they are generally deficient in fat, and often contain an excess of carbohydrate - principally free starch, which, in the early months, the infant is unable to digest. They frequently do not possess the antiscorbutic element. They are nearly always troublesome to make, and expensive to buy; and it is difficult to see what real advantage they possess: for, if carbohydrate were required in the food, it is easily supplied by oatmeal or barley-jelly. They are, however, of some use in emergencies - especially during the summer, if it is difficult to get pure and clean milk, or if diarrhoea is prevalent. Their prolonged use is dangerous to growing infants - the more so as, at first, there may be gain in weight, and no untoward symptoms appear for some months.

This point is emphasized by G. Still (Practitioner, 1904), who argues, as a general principle, that the unsuitability of a particular food is not proved by the fact that it is taken well and produces no ill effects; for it may be many months before bad symptoms, such as rickets or scurvy, appear.



As the onset of rickets is so insidious, and as many months may elapse before symptoms pointing to the disturbance of the osseous system draws attention to the presence of the disease, this delay in the appearance of ill effects, due to starchy diet, should be always kept in view when the feeding of an infant is considered.

Keller (Berl.klin.Woch., Sept.3, 1906) gives the same warning, and states that, though symptoms may be slow in appearing, when once evident, they are very serious - especially if dryness of skin, muscular rigidity, difficulty of free movement, weakness of the heart, and anorexia be present.

Starch-fed children have a low/resisting-power to disease: they recover slowly, and rapidly succumb to infectious disorders or to intoxications. Even with a rosy colour and no digestive disturbance, a child may have its constitution undermined by improper feeding with starch food. The weight of the child may be no real index of its vitality or progress; and, therefore, the condition of the skin and its muscular system should be noted with the utmost vigilance.

The part carbohydrates play in the production of rickets is not quite clear. The child, nourished on an excess of carbohydrates, is easily affected by digestive disorders, and its power of resistance is low. Disorders of malnutrition, once initiated, are not easily shaken off, and rickets may then develop. It has been shown that any disturbance of the food-ratios affects adversely the organism; and, if one is deficient or in excess, the other elements are not so advantageously dealt with or assimilated.

It has been suggested that though rickets is frequently due to deficiency of fat in the food, it may be also caused by a food that has a sufficiency of fat, the assimilation of this element, however, being interfered with by an excess of carbohydrate. An excess of carbohydrate, soluble or insoluble, will interfere with the proper assimilation of the fat, and, therefore, a diet, poor in fat but sufficient to prevent malnutrition, will, in the presence of carbohydrates, be too weak - the child suffering from malnutrition and rickets (Still, - Practitioner, 1904). If rickets is caused by a deficiency of fat in the diet, it is probable that, in the case of an infant from six to seven months of age, a mixture with 1.5 per cent. of fat will not be sufficient to prevent its appearance, and that 2.5 per cent. would prove insufficient if the carbohydrate in the food is excessive.

The three great elements of the food, - proteid, fat, and carbohydrate, - are intimately associated with one another; in seeking for the etiology, and the lines on which the treatment of rickets can best be conducted, it must be remembered that, though the main evidence points to deficiency or defective assimilation of fat in the diet, the proteid has an important part to play in the child's nutrition; and that excess of carbohydrate may interfere seriously with, or hamper, the proper absorption of the other elements - even though the amounts were deemed sufficiently safe for nourishment, growth, and the prevention of the disease.

THE FERMENTS OF MILK. - In addition to the elements proteid, fat, and carbohydrate, as well as salts and lecithin, the milk of all mammals also contains a number



of ferments - the true value of which we are not able at present to estimate.

The stomach of the newborn child is deficient in digestive ferments, and probably also in ferments called trophozymoses, which may be supplied in the mother's milk. Unless these are present, the child cannot digest or assimilate its food, and finally transform it into cell tissue. These ferments possess some special biochemical action, which is probably rendered inert when the milk is boiled, in order to render it sterile. All animals do not possess the same ferments; but, with special foods or by feeding them with the ferments absent in a particular species, the missing varieties can be made to appear.

It has been shown by Concetti's assistants (Arch. de Méd. des Enfants, March, 1902) that human milk contains ferments which are absent from, or only slightly present in, the milk of the cow or goat, and that ~~sterilisation~~ destroys any ferment that may be present. The ferments present in human milk are not peculiar to it, and can be made to appear in the milk of the cow by appropriate feeding.

Spolverini (Arch. de Med. des Enf., 1901) fed goats and cows on a germinating barley: he then found amylolytic and hydrating ferments in the milk, which were not present normally, but which are always present in human milk. The same author (Rev. d'Hyg. des Mal des Enf., 1902) gives the following classification of the ferments of milk:

A. Ferments of Elimination.

B. Ferments of Secretion.

(1) Trypsin Ferment. - Active in goat, dog, and cow, less active in woman and ass.

(2) Pepsin Ferment. - Less active than (1).

(3) Amylolytic Ferment. - Never found in cows or goats; always found in woman and dogs, where it is highly active.

(4) Hydrating Ferment. - Transforms salol into carbolic acid and salicylic acid. Always present in woman and dog; not found in cow's milk.

(5) Lipase. - A fat-splitting ferment; present in all milks.

(6) Oxydase. - Very active in cows and goats; scarcely noticeable in woman.

(7) Glycolytic Ferment. - Present in all animals in varying degrees of activity.

Milk must therefore be considered, not merely as a mixture of nutritious chemical substances, but also as containing active bio-chemical elements, which perform their function in the building-up of the organism.

During the last few years, owing to the great difficulty in obtaining reliable and pure cow's milk and the dangers associated with milk that is impure or tainted in slight degree, many people have resorted to the use of sterilised milk; and the method has been adopted by nearly all municipal depôts for distribution to the poor.

The advantages of this form of feeding are doubtful: for the spores of the most virulent microbes are not thereby destroyed, though probably the useful varieties, the "tame microbes" (Lauder Brunton, - Lancet, Nov., 1906)

are rendered inert, and the milk damaged. Furthermore, there is always the risk that the child fed on sterilised milk throughout will fail in development, and also show symptoms of scurvy. Cheadle (Artif. Feeding, p. 75) remarks that such sterilised-milk-fed children eventually lose firmness of flesh and vigour, and do not thrive into robustness. The process impairs the value of the nitrogenous element and the antiscorbutic property. The boiling probably also destroys the ferment.

It is not quite clear of the use of sterilised milk can cause rickets; and on this subject there is considerable difference of opinion. The original view of German observers (Müller, Bohn, Hirschsprung, and Senator - 1859 - 1873), that scurvy was an acute form of rickets, is now generally abandoned. Although rickets and scurvy are often found together in the same child, the symptoms are quite distinct; and there are also marked differences in the treatment to be adopted.

The main feature of scorbutis is the tendency to subperiosteal haemorrhage, subcutaneous extravasations, spongy gums, and haematuria. It is a haemorrhagic disease, and this does not also apply to rickets. The alteration and correction of the diet produces a slow and gradual improvement in a child suffering with rickets, and the administration of antiscorbutic remedies produces no change; but, in the case of scurvy, if fresh vegetables or fruit-juices are added to the food, then there is an immediate and rapid recovery from the disease (C. Allbutt, - Syst. of Med., Vol. v). The occurrence of the two diseases at the same time is due to the fact that the foods given are sterilised, or patent farinaceous foods, which lack the antiscorbutic element, and also are deficient in fat, proteid, and phosphates.

"It is possible that the periosteal activity and the vascularity of young growing bone may also be a factor in the meeting of scurvy and rickets (C. Allbutt, - loc. cit.). Though it is doubtful whether sterilised milk can produce, de novo, rickets, it is possible that a child, nourished on an inert food lacking the digestive ferments and enzymes present in fresh milk, will grow up less resistant to the various catarrhs, and rickets appear as a sequel to these disorders and chronic malnutrition. If, in addition, the milk is deficient in fat and proteid, the tendency for the child ~~to~~ to develop rickets will be considerably increased.

At a meeting of the British Medical Association, held in Manchester in 1902, Jules Comby, of Paris, held that modified artificial milks were responsible for the production of anaemia, rickets, and infantile scurvy; and he appears to have noticed that these diseases, especially scurvy, are observed in those countries where modified milk is most used. In America, where modified and sterilised milks and foods are largely used, these diseases are very prevalent.

E. M. Sill (Med. Rec., Dec., 1902) observed, at a dispensary, 179 consecutive cases fed, for periods varying from three to eighteen months, on carefully modified milk prepared in a laboratory - all bottles used for the food being carefully sterilised. For nine months of the year the milk was pasteurised, and during the summer months was sterilised. In 97 per cent, of the

cases there were unmistakeable signs of rickets or scurvy, most of the cases being rickets, or a combination of rickets and scurvy - the one merging into the other. The author regards the pasteurisation of the milk as the cause of these conditions found in children.

Though scorbutus and rickets are frequently associated, Holt (Dis. of Children) does not consider that they are really connected, nor does he regard them as different forms of the same disease. The American Pediatric Society (ibid.) endeavoured to trace the association between rickets and scurvy. Out of 340 cases, it was found that in 152 - or 45 per cent. - rickets was present. In 50 of the patients, rickets antedated the appearance of scurvy.

In an article on "Barlow's Disease", E. Ausset (L'Echo Méd. de Nord, Jan., 1903) concludes that:

(1) Barlow's disease is a haemorrhagic form of rachitis.

(2) That all children with Barlow's disease are rachitical, with or without bony deformity.

(3) That the coexistence of Barlow's disease and rachitis would indicate a similar etiological factor.

The same author (Ibid., May, 1902) records his observations in 682 cases (456 bottle-fed, 59 breast- and bottle-fed, and 167 breast-fed), and states that it is an exaggerated view to hold that sterilised milk can cause rachitis, but that it is the wrong and injudicious feeding which actually causes the disease. A breast-fed baby becomes rachitic is bad hygienic principles cause prolonged digestive disturbances. He considers sterilised milk of great value, and in wealthy families preferable to a wet-nurse. The establishment of milk stations, where the milk is dispensed carefully and where mothers are advised how to accurately administer the same, will help, he believes, to diminish the cases of rickets.

Variot (La Tribune Méd., 1902) has come to the conclusion that, - aside from mother's milk, which nothing can perfectly replace, - the use of sterilised milk is almost as safe as a wet-nurse. There are so many possible objections to a wet-nurse that he advises sterilised milk for a normal infant, and reserves the wet-nurse as a last resort, in cases in which the child does not thrive on other treatment.

The writer has made inquiries concerning the babies attending the municipal depôts of Liverpool. So far as the Medical Officer of Health is able to observe, the use of sterilised milk does not cause rickets. Dr. Mussen, Assistant Medical Officer, has seen no case of genuine rickets than could be attributed to the use of sterilised milk sent out by the Corporation. He has seen a few cases of slight scurvy; and it is doubtful whether the number which arise in this way is not less than under any other method of feeding. The sterilised milk helps to prevent the summer diarrhoea, and therefore is safer in hot weather than any other form of food.

Beyond a suspicion that sterilised milk - especially if its use is very prolonged - may cause the disease, the conclusion is that sterilisation, in itself, is not a cause of rickets. Nevertheless, sterilisation has great drawbacks, and it is well known, as pointed out by Daniëhoff (Rus. Vrat., Vol. ii, 7), who made 175 analyses of sterilised milk, that the prolonged employment of that liquid as an infant's food lowers, or completely



deranges,metabolism - throwing an extra strain on the organism,and thus paving the way for a host of ailments. The nutrition of the system is inadequately maintained, and the frequent result,therefore,is constitutional disease.

Though we cannot definitely state that sterilised milk can cause rickets,it is possible that feeding on a milk deprived of its vitality,its ferments,and its energy will lower the system and predispose to this disease.If three children were selected,- a breast-fed baby,one artificially fed with fresh cow's milk,and another fed with sterilised milk,- the last case (assuming all healthy at the commencement) would suffer most in nutrition,and probably develop scurvy,if not also rickets.

It is therefore advisable in discussing the etiology of rickets to include in the inquiry the use of sterilised milk and sterile patent foods,though the dangers of either will be largely increased if they prove deficient also in the important elements fat and proteid.

A food to nourish an infant should be fresh and free from dangerous organisms;and the vital principles (the ferments) also should be unimpaired.These are present in the ideal form in breast milk,and if, unfortunately,cow's milk must be used,every endeavour should be made to obtain,if possible, clean milk,which does not require to be sterilised or cooked in any way that will injure the vital ferments.

**CONCLUSIONS.**- Though we are compelled to recognise the fact that the faulty nutrition of the infant is the great underlying cause of rickets,- as new facts arise pointing to the great differences between human and cow's milk,- it becomes more evident that it is unwise, **generally** speaking, to point to one element in the food as the sole or principal factor in the production of the disease.

Test-tube experiments will not supply the answer to the vexed question of the cause of rickets:for reactions of substances,in vitro,may not be the same as in the living stomach. It is also doubtful if experiments on animals help much further to elucidate the mystery:for animals and human beings may react quite differently to similar agents.

We know little of the chemical nature of human milk,or how it differs from the milk of the cow or other mammals.We are aware that the proteid elements, casein and serum albumin,differ,by nature and by proportion,in the milk of the woman and the cow;we recognise that the fats differ,the milk of the cow being relatively rich in fatty acids,whereas the woman's milk is poor in these substances;we also are aware that both contain milk-sugar and salts in varying proportions;but we cannot yet explain the vital principles hidden in the human milk,be they ferments,enzymes,or antibodies,which render human milk,taken into the blood of an infant,a life-protecting fluid,while the milk of the cow or other mammal may become a poison, under certain conditions,as lethal as the germs of cholera,typhoid,or diphtheria.It is even necessary to consider the food of the infant from a biological and

physiological, as well as from a chemical standpoint, keeping clearly in mind the principles that the nutriment is intended to act as a food, but also to develop the alimentary tract, - so that, as the digestive secretions of the child's stomach and intestines are gradually created and brought into use, they may act chemically upon the milk and retain it for lengthening periods in the stomach, thereby preventing its being passed too quickly into the intestines. Gradually, by this process the stomach is enabled to fit itself, anatomically and physiologically, for the food of the adult when the period of infancy is passed. The human milk retains the same composition throughout lactation, but is changed by the action of the developing gastric secretions into forms requiring slight, moderate, or complete gastric digestion - until at last the animal is able to digest and assimilate the food of the mother, and can be considered physiologically separate from the parent.

There is not so much danger in ~~deficiency~~ of one element as in the ~~disturbance~~ of the ratio of all the important elements of nutrition - the proteids, the fats, and the carbohydrates.

Rickets is caused by a food, usually deficient in quality, though the quantity may be ample to support life in the infant, and even enable it to gain considerable weight. At the mother's breast, the child gets a milk, in which the proteids, the fat, and carbohydrate keep a fairly constant ratio. Towards the end of lactation, in pregnancy occurring during suckling, or in an ill-nourished mother, the proteids fall to the vanishing-point; and, even though the fat has varied little, malnutrition and rickets may be lit up in the child.

If cow's milk be the food, it may be supplied deficient in fat, or this element may be so excessive that it hinders the absorption of the proteid. Digestive disorders are set up; and, though the child may be fairly well-nourished, it may gradually waste and show symptoms of rickets.

The excess of sugar in condensed milk, together with the deficiency of fat, once more supplies an ill-balanced scale of nutriment, tending to the production of flabbiness, debility, and the rachitic dyscrasia.

And, worst of all, the patent farinaceous foods, - rich in carbohydrates, soluble and insoluble, and frequently supplying excess of starch, which in itself is an unnatural food for infants, - hinder the absorption of an adequate quantity of fat by the infant, which, slowly but surely drifts into a rickety condition, - although for many months it may be plump and well-nourished, and suffering from no apparent disorder of digestion.

Therefore, though giving due weight to the theory that the deficiency of fat strongly tends to the production of rickets, the writer is of the opinion that no one element of the food should be unduly considered to the exclusion of the others. Proteids, fat, carbohydrates, and, in some lesser degree, the salts are so

intimately associated, that any disturbance of the balance inevitably causes digestive disturbance, malnutrition, and frequently rickets.

In the present state of our knowledge it is not easy to state why, at one time an infant should develop marasmus, and at another time rickets or scorbutus.

Possibly marasmus, scorbutus, and rickets are in some way related; and the special disease is determined by different agents - microbic, scorbutic, and toxic - conveyed in the food, or at work in the system.

The possible causation of rickets by the presence of toxins, together with the lack of antitoxins in the child's blood (which nature intended to be supplied in the maternal milk) has been suggested in another section. These toxins would supply an irritant circulating in the blood, and cause the disturbances of various organs which are made more evident in the lesions of the osseous system. Cold would lower vitality, and allow the toxins more play; and lack of sunlight and fresh air would reduce the vitality of the infant. But it seems more probable that the toxin is not derived from a germ, but from some poison in the milk which the infant is able to resist with its own antitoxins, if fed on its natural food. If this be so, it seems almost impossible to artificially construct a food which will contain all the properties of maternal milk, or can be used with safety for any lengthened period.

#### Chalmers Watson's Observations.

Chalmers Watson (Lancet, Dec. 18, 1906) publishes the result of some interesting experiments on young rats, whose parents, before and during gestation, were fed on an excessive meat diet. The female rats in question were fed, for some weeks or months prior to pregnancy and during lactation, on a diet of ox flesh; and their young, after weaning, were kept upon the same diet. One hundred meat-fed rats, in age varying from one day to three months, were used in these experiments. Control animals were fed on a bread- and skim-milk diet.

Post-mortem examination showed, macroscopically, (1) a general softness of the osseous system - this condition being uniformly present in all meat-fed rats, and accentuated as they advanced in age; (2) A darker colour of the long bones, especially the ribs, due to increased vascularity of the tissue. During the second month, curvature of the spine and long bones occurred; and there were also lordosis, bending of the ribs at their angles, and curving of the limbs in lesser degree. The curving of the bones was often associated with enlargement of the costo-chondral junction. In about 15 per cent. of the cases, small white nodules were observed in the ribs standing out as pale bead-like prominences in the substance of the dark bone of the rib. These proved, on section, to consist chiefly of cartilage. In pronounced cases, the changes were similar to those seen in advanced cases of rickets in the human subject. This, however, is not confirmed when a microscopic examination is made: for, though it is seen that ossification is delayed and imperfect, involving enchondral and periosteal bone-formation, the minute structure of the epiphyses is normal - even though the animal showed pronounced rachitic changes in the skeleton. The bony trabeculae



are thin; there is a great increase in the size of the medullary cavity; and the bone-marrow (in meat-fed rats of six weeks and upwards) showed a great excess of fat. There was often a great increase in the number of thin-walled vessels, which were full of corpuscles (red) in the medullary spaces. The white nodules observed in the ribs consisted of cartilage cells, derived from the periosteum, which at the periphery are being transformed into bone.

The results of these experiments at first suggest a condition of rachitis, - the delayed and imperfect ossification, the increased vascularity, the increase of the red blood-corpuscles in the medullary spaces, and the nodules of cartilage in the ribs resemble this disease in infants; but that some other condition than rickets is present is proved by the normal appearance of the epiphyseal lines of the bones.

The findings in these experiments - especially the microscopic details - make one venture to doubt the reliability of Guérin's assertion, that he produced rickets in animals by feeding them on a diet of raw meat; and also to speculate whether the condition was similar to the disease developed in rats kept on the excessive meat-diet.

Chalmers Watson further alludes to one very interesting case, in which a tuberculous mother, treated successfully with large quantities of raw meat, marries, and, while continuing the excessive meat-diet, in eighteen months has a child. The infant was bottle-fed until it was a year old, and then unaccountably fails, and developed a condition of anaemia. It was treated with meat-juice, but this only made matters worse, and finally the child died. During life Chalmers Watson noted that the child's symptoms resembled those found in the meat-fed rats; and a post-mortem examination of the tissues - especially of the radius - showed conditions identical with those present in the ribs of the animals. The case shows how profoundly the general health and the feeding of the mother may influence the child, both in utero and after birth.

It seems probable that, by observing the diet of the parents both before and during gestation, new light may be thrown on the diseases of infancy; and this should be always be borne in mind when considering the etiology of rickets. The matter will be again referred to when discussing the prophylaxis of the disease.

#### DEFICIENCY OF LIME SALTS.

As the most evident are in the skeletal system of a child affected with rickets, special attention has been given by many observers to the pathological lesions of the bones, in the hope of finding a clue to the casual agent of the disease. It was early known that there was a poverty of mineral constituents, principally due to a deficiency of lime salts; and it was therefore assumed that the lack of these elements, either through deprivation or through some want of assimilation, would cause the development of rickets in an infant. Most rickety children are overfed, and, on unsuitable food, they probably take in a sufficient quantity of phosphate of lime, which they are unable to assimilate readily, owing to some disturbance of function set up by disorders of digestion.

Chossat (1842), by withholding lime salts from the food of pigeons, was able to cause softening and curvatures of the bones; but he did not produce true rickets. Probably some form of osteoporosis was induced in these birds.

Friedleben repeated the experiments of Chossat, and was also unable to cause true rickets, though the bones of the animals became very fragile; but Voit claims to have produced rickets by this means.

Baginsky, from actual experimentation, concluded that the elimination of the lime from the food - especially if lactic acid is present - will cause this disease.

Wegner, of Berlin, showed (1871) that if, while administering doses of phosphorus to young animals, lime salts were withheld, there arose an affection of the bones exactly like rickets; and he supposed that the phosphorus acted as a stimulant to the ossifying tissue.

The theory, that rickets is due to a deficiency of lime salts, is very much weakened by certain facts - in effect as follows:

(1) Though cow's milk is six times ~~weaker~~ in lime salts than human milk, breast-fed infants rarely suffer from rickets: whilst, amongst infants artificially fed and taking cow's milk in some form or other, the disease is very common. Still, it is possible that the infant is unable to use effectively the lime salts in the cow's milk: for the calcium salts are intimately associated with albumin of the casein, and it is this element that the infant finds difficult to digest and often rejects as tough curds.

(2) In limestone districts, where the water may be impregnated with lime salts, the children are frequently rickety (C. Allbutt, - System of Med., Vol. iii); ~~but does~~ the addition of lime-water to the dietary <sup>prevent</sup> the occurrence of the disease.

It was formerly stated that the common occurrence of rickets in the children of the city of Glasgow was due to the want of lime in the water of Loch Katrine; but, although this water is shown to be almost of the distilled variety, the tendency now is for the disease to disappear (Scott, - Phys. Deterioration Rep.). All the witnesses at the Commission on Physical Deterioration (Greenwood, Ashby, Scott, Vincent, Cameron) refused to subscribe to the theory that the want of lime in water can cause rickets.

Sir L. Ormsby was inclined to believe that, in cities with a water-supply containing little lime, deformities of the limbs are much more prevalent: yet, there is very little lime in the water-supply of Dublin, and rickets is by no means a common disease.

Sir C. Cameron mentions that in Dublin, which is supplied with a water possessed of only two degrees of hardness, it was predicted that the children would be extraordinarily rachitic; but one does not often see rickety children in that city. Our author believes that this is because there is very little hand-feeding practised by the populace.

It seems evident, therefore, that the amount of lime in the drinking-water has practically no bearing on the presence of rickets in any locality.

(3) The administration of lime salts alone, or in medicine containing preparations of lime, seldom influences or cures the disease.

(4) Farinaceous foods are rich in lime and phosphoric acid (Luff): yet, children fed with these preparations - especially of milk is excluded - are very liable to rickets.

(5) Rickety changes, increased vascularity, and proliferation of cartilage have been met with in normal calcified bone. As uncalcified cartilage consists largely of lime, marked proliferation would seem impossible without a proper supply of that substance (Keating).

(6) Even though no alteration is made in the diet, a child may spontaneously recover from rickets.

There may be a sufficient supply of lime, but a defect in its assimilation. Pommer held that, though sufficient lime was ingested, it was not absorbed, owing to the diminished alkalinity of the blood; but Sweltzner has shown that the alkalinity of the blood is not diminished in rickets.

It seems much more probable that, if the lime salts are assimilated in an insufficient amount, the loss is to be accounted for by the inability to digest the casein of the milk; but this fails to explain the occurrence of rickets on a purely farinaceous diet.

Kassowitz regards rickets as a chronic inflammation starting in the bone-forming tissues, and compares the inflammatory process to interstitial keratitis, or to interstitial inflammation of the liver produced by phosphorus. He does not consider the **poverty** of lime salts in bones to be peculiar to rickets: for it is to be seen in every form of inflammatory osteoporosis, - and affirms that of more importance is the intense vascularity of the tissues engaged in the formation of bone, which he regards as the **initial** and principal sign of rachitic disease. He endeavoured to discover if an artificial congestion of the limb would lead to rickets: he applied an Esmarch's bandage to the limb for several hours a day, and repeated this process daily for several weeks. An examination of the bones showed that the increased flow of blood had prevented the deposition of new bone, and also had **destroyed** bone already formed; and he observed that there was a proliferation of the cartilage as found in rickets. From this he argues that a hyperaemia of the bone produces poverty of the inorganic constituents, and that an inflammatory process in the bones is the cause of the deficiency of the lime salts always noticed in rickets.

The effect of a diet poor in lime salts has been studied by Miwa and Stoltzner, who fed a puppy, six weeks old, for fifty-five days on a diet of raw horse-flesh, fat, and distilled water. After three or four weeks, there developed typical symptoms of rickets - enlargement of the epiphyses, rachitic rosary, and curvature of the long bones; but the anatomical changes suggested rather osteoporosis than rickets.

This experiment was repeated by Reimers and Bayer (Centralbl. f. inn. Med., Sept. 30, p. 953; Med. Rev., Vol. ix, p. 101), who fed puppies, about ten weeks old, on a diet of horse-flesh, pork, veal, horse-fat, and distilled water. On the eighth day, the animals were indisposed to move; and



this condition gradually increased, while any sudden movement occasioned cries of pain. The gait was waddling, the fore-limbs assumed the shape of an "O", and the hind limbs that of an "X". The lower end of the radius and ulna were enlarged. After continuing the experiment for thirty-one days, the animals were killed. There was a considerable accumulation of fat, the muscles were unaffected, a rickety rosary was present, and there was enlargement of the epiphyses of the long bones. The long bones, when dried and macerated, proved unusually light, with a rough and porous surface. They floated in water, whereas the bones of the dog in normal condition will sink. On longitudinal section, the compact substance was found to be exceedingly narrow, and the meshes of spongy tissue correspondingly wide. The growing cartilage was wider than normal, and in parts there were indications of periosteal changes. The adjacent uncalcified bony layer showed no signs of proliferation, and the process was essentially one of osteoporosis. A puppy with spontaneous rickets was killed for the purpose of comparison. The macroscopic and microscopic appearances showed chiefly proliferation of the osteoid tissue, and were distinct from changes due to a deficiency of lime salts. Our authors conclude that deficiency of lime is not the only factor in the production of true rickets, and suggest that the other factor is heredity: for, if both parents have been rickety, the offspring specially liable to the disease. They also point out that some children seem more predisposed to the rickets than others, and these, though they are brought up on the breast, do not always escape the disease. As a rule, predisposed children do not become rickety unless artificially fed. It is possible that the changes found in these puppies represented an early stage of rickets, which, if the diet had been continued, might have been followed by proliferation of osteoid tissue. This view is supported by the fact that cases of typical rickets in man, in which the changes in the uncalcified layer of osseous tissue were slight, and much less marked than those in the cartilages and periosteum.

Chalmers Watson, we have seen, has shown that feeding young rats upon an excessive raw-meat diet produced a disease in these animals characterised by softening and curvature of the bones, and, in 15 per cent. of the cases, white nodules in the bony parts of the ribs. Microscopic examination of the epiphyses proved that the condition was not one of rickets, although the naked-eye appearances were very similar to this disease. At the Pathological Society of London, on December 18, some criticism (Lancet, Dec. 29, p. 1779) was passed on these experiments, which inclined to show that the results were due, not so much to the excessive meat-diet, as to a deficiency or interference with the absorption of lime salts.

This view was taken by Dr. E. Sprigg, who considered that the specimens and slides shown by Dr. Watson exhibited similar changes in the tissues to those described by various observers as resulting from a diet deficient in lime. He referred to the experiments of Voit, Seeman, and Baginsky, who fed young dogs on flesh, fat, and distilled water. The animals showed no change for a time, putting on weight; but they became gradually

weak, mentally slow, and died. The changes found in the osseous tissue were increased vascularity, irregularity of the cartilage cells at the epiphyses, the formation of imperfect osteoid tissue, and diminution of the inorganic matter. The deformities produced by a diet deficient in lime were less marked than in large animals.

Dr. Hale White also doubted that excess of meat in the dietary was the sole cause of this condition in the rats: for animals who were purely carnivorous were never so affected, not did the Eskimo, who was a pure meat-eater, suffer from this disease described by Chalmers Watson. He agreed with Dr. Sprigg that the absence of lime from the diet was the probable explanation of the changes produced in the bones of these animals.

The conclusion to be drawn from these experiments of Chalmers Watson is twofold in character:

(1) That, though experiments in animals are very unreliable for comparison with the human infant, a diet excessive in meat, and deficient in lime salts is productive of a disease marked by softening of the bones, increased vascularity of osteoid tissue, and debility, - comparable to the condition set up by other workers, including Guérin, and described as rickets.

(2) That, though the macroscopic appearance - evidences by the bending of the bones and the increased vascularity - is indistinguishable from rachitic disease, the microscopic examination of the epiphyses clearly proves that the condition is not one of true rickets.

These results, when compared with those of Reimers and Baye, suggest that the disease usually produced in animals, fed on a meat-diet, is more closely allied to osteoporosis than to rickets.

#### LACTIC ACID.

If a bone is subjected to the action of an acid, it becomes softened and deprived of its lime salts; and it was therefore inferred that there might be some acid, acting on ~~the~~ bony tissues, which was the active agent in the causation of rickets. And, as rickets is generally associated with considerable disorder of the digestive system, it was further supposed that the acid at work and causing the disorder was most likely to be lactic acid set free by the fermentation and decomposition of food in an unhealthy stomach, which is always disordered and frequently also dilated (Comby).

Heitzmann and Monti were the chief upholders of this theory; and the latter authority considers that the association of the secretion of lactic acid, together with a diminution of hydrochloric acid of the gastric juice, will serve to explain the cause of rickets. The view held by Heitzmann was that lactic acid stimulated excessive growth by irritating the young ossifying tissues, thus causing the manufacture of premature bone; but others have suggested that the lactic acid combined with the lime salts and carried them away in solution, and thus an insufficiency was supplied to the osseous system. But the presence of lactic acid in the bones has never been demonstrated, although it has been found in the urine. Queltzer (1883) examined the urine of rickety children, but found no excess of lime or of phosphoric acid (Keating).

Heitzmann fed ~~varnivora~~ on lactic acid, and also injected it subcutaneously, at the same time keeping them on a diet deficient in lime. This treatment produced rickets, with a condition of bronchial and alimentary catarrh.

Korsakow repeated these experiments upon dogs, but with negative results.

Spellmann injected a rabbit with 10 c.c. of a 1 in 200 solution of lactic acid, and for a period extending over a month and a half; but he was unable to produce rickety changes in the bones.

The theory, that lactic acid causes the deficiency of lime salts in the bones and a rachitic outcome thereof, is weakened by the following additional facts:

(1) Some children, even though fed on starchy food, have no disorders of digestion which would favour a production of lactic acid, but digest the starch well, and grow fat upon it; yet, in the end, they develop rickets. According to Cheadle (Artif. Feeding), who has made repeated observations, the rickets can be cured, although the child is still fed on the farinaceous food, if certain elements in which it is deficient - generally fat and proteid - are added to the diet.

(2) Even if lactic acid did not exist in the blood, it ought to be neutralised by the alkali present; and therefore the starchy element would not be directly harmful.

(3) Animals, fed on a diet which does not lead to the production of lactic acid, may develop rickets. Guérin fed young animals on meat, depriving them of mother's milk, and they developed rickets. Successive litters of lion-cubs at the Zoological Gardens, London, fed on tough fibrous meat and bones so hard that their teeth could not make any impression on them, became weak and rickety: they ultimately died of exhaustion. In both these experiments there would be a deficiency of fat and proteid; but there was no element in the food that would be likely to produce an excess of lactic acid in the stomach.

The lactic-acid theory is not well supported by any experiments or facts; and it is not seriously considered at the present time as explaining the production of rickets. Indeed, Barlow and Bury (Keating's Ency. of the Diseases of Children) cannot conceive the possibility of any acid being carried in the blood to dissolve out the lime from the bones; and it is advisable, therefore, to seek for the cause of rickets in some other direction.

#### DIMINUTION OF GASTRIC HYDROCHLORIC ACID.

Monti, though regarding the presence of lactic acid in the stomach as causative of rickets, believes that its action is much increased when the amount of hydrochloric acid in that organ is diminished, which is of frequent occurrence in children suffering from rickets; in every case he found a history of gastric disorder. Zweifel also lays stress on the diminished amount of hydrochloric acid present in the stomachs of rickety children, and shows that the production of that chemical depends on the amount of sodium chloride taken with the food. He observed that the nursing mothers of



Saxony received very little salt in their food - in consequence of which infants suckled at the breast frequently suffered from rickets.

Dr. Shaw (Arch.Ped.,1903),for the past ten years, influenced by this statement,has added salt to the food of every infant,and believes that this has diminished the number of cases of rickets.

In connection with this theory it is of interest to note that P. Nobécourt and S. Vilry (Rev.mens.des Mal.des Enf.,1904) find that the addition of sodium chloride to the food of infants has a favourable influence on body-weight,and that small amounts - from four to five grains daily - give the best results. The most marked benefit was derived in the case of premature infants,as well as in those of very low weight.

#### PHOSPHATE OF POTASH.

Delcourt (1899) maintained that he was able to produce rickets by the administration of phosphate of potash,and obtained positive results in the case of dogs fed on this compound.

Spellmann,however,fed rabbits and a pig,for nearly a month,on phosphate of potash,and also injected the drug subcutaneously into a young rabbit;but in no case was he successful;and examination,post-mortem,of the bones showed no evidence of rachitis.

None of the chemical theories satisfactorily explain the reason for the hyperplasia of the growing end of the rachitic bone;and this is probably a more important matter than the absence of lime salts in the tissue. At the same time they fail to account for the deficiency of organic matter;and it does not seem probable that any chemical theory will offer sufficient explanation of the cause of rickets.

Barlow and Judson Berry (loc.cit.) support the theory,advanced by Kassowitz,that the changes in the bones are due to some inflammatory reaction - probably the result of a direct irritation in the young ossifying tissue,which would react readily to an injurious influence,and thus produce the rachitic dyscrasia. This suggests that there may be bacteria or their toxins circulating in the blood,which,by their irritative action,set up inflammatory reaction in young bone, delaying ossification,and thus light up a suitable condition for rachitis to develop its train of symptoms and malevolent systemic manifestations.

#### CLIMATE AND SUNLIGHT.

The geographical distribution of the disease is of some considerable interest;and it may be stated that rickets is of world-wide distribution,but,nevertheless, much more prevalent in cold damp countries - more especially where there is lack of sunlight during the long winter months. It is favourably influenced,and tends to disappear,wherever there is dryness,sunlight, and plenty of warmth.

It is more frequent in the temperate zones,more particularly in certain parts of Europe and North America;it is common in England,France,Germany,Holland, and Northern Italy,and to a large extent is a disease of all the great modern cities and manufacturing towns.It is also found in the large towns of Australia,

and has even been met with in the bush (Muskett).

According to Palen,rickets is almost unknown in the extreme north,Greenland,Iceland,Norway,and Denmark; possibly because in all these countries fat will figure in the food,as it is required for heat-production.

The disease is very rare in China,Japan,Greece, Algiers,and Turkey;it is practically unknown in the tropics,or,possibly because of the mildness of the symptoms,it remains unrecognised.It is very rare in mountainous districts,or at high altitudes - especially if the soil is dry.

It affects all races equally,though a cold climate and a cold environment have a strong influence in predisposing to or producing the disease.In 1881,it was scarcely known in America,but now,in the great cities of that continent,no race is exempt from the disease. In New York and Philadelphia,the greatest susceptibility appears to be amongst the Italians and negroes;and the worst cases are almost invariably observed amongst these nationalities (Holt).It is not,however,confined to these two races (Koplik).The Italians suffer very severely, and,with them,even breast-fed babies become liable to the disease.

These two southern races bear badly the transplanta- tion from the warm semitropical countries to more temperate climes,and suffer severely from the confined life of the northern cities:for they are obliged to live in dark cellars or tenemented houses,where there is little sunshine,and they miss the genial warmth and the open-air life of their native lands.Their dietetic customs remain unaltered:invariably they continue to partake of the food that is customary in their own countries,and on which they do not there develop the disease,- so that the prevalence of rickets in these two races,under new conditions of life,is not so much due to improper food as to the lack of warmth,sunlight, and fresh air. There may,however,be some racial peculiarity,which tends to make them specially susceptible to rickets.In the Southern States,rickets is not common amongst the negroes,because they are able to enjoy plenty of fresh air and sunlight;and probably,too,they lead more open-air lives,and have houses which are better ventilated by constantly open windows. In Maine coast towns,the children are able to have plenty of air and sunlight;and,although many are badly fed,and often by artificial means,rickets is but rarely seen in this part of America.The disease is considerably modified by climate;and,in semitropical countries,may appear in a form,so altered and modified that the true nature of the affection may be entirely overlooked. In New York, deformities are late in appearing;and cases which show slight symptoms,- such as fretfulness,perspiration about the head,without any gross deformity of the bones,- may pass unnoticed,and not be recognised as manifestations of the rachitic dyscrasia. As a result of an examination of the children in the New York Infant Asylum,Lewis Smith discovered that one case in nine showed signs of rachitis.

Mild forms of rickets are not infrequent in Australia (Muskett),but,being modified by the semitropical climate,the bony deformities are rare.

Dr. Muskett (Prescribing for Infants) believes that the absence of deformities is due to the fact that, in a semitropical climate, the children require less animal fat and proteid in their food, as the starchy elements satisfy the requirements of the system, and the bony structures are not so injuriously affected as in colder climes.

Rickets is more often seen amongst the children of the poor; but the rich are not exempt from the disease. Scurvy is a more common disease than rickets amongst the well-to-do, owing to improper feeding with food deficient in the antiscorbutic element.

Goodhart states that 50 per cent. of the children attending the hospitals in London suffer from rickets; and Barlow and Bury (loc.cit.) give the following statistics of the hospital patients in the large cities of Europe:

London .....	30	per cent.	
Prague .....	30	"	"
Manchester .....	30	"	"
Vienna .....	80	"	" (Kassowitz)

Under 3 years of age.

Kassowitz (loc.cit.) doubts the accuracy of these figures, and believes that if craniotabes and swelling of the ribs were included, the statistics of the English towns would be higher. The above-mentioned authors agree to this, and are of the opinion that 50 per cent. of the children, attending hospital, under two years of age have rachitic symptoms, which would bring their figures into agreement with those of Goodhart. Further information and statistics are supplied by the witnesses examined by the Physical Deterioration Commission.

Dr. Eicholz was of opinion that children suffer from rickets more acutely, if not more generally, in the North of England than in the south; and in the north there is a greater proportion of children deformed than in the metropolis. The employment of the mothers partly accounts for the greater prevalence of rickets; but the true cause is poor and unsuitable food.

Dr. Hall, of Leeds (Quoted by Dr. Young), finds 50 per cent. of rickets in a poor school, 8 per cent. in a good-class school, and only 7 per cent. in a poor Jewish School. He examined 2335 board-school children, and found that half of the children were rachitic, and more than half had bad teeth. He gives the Leeds average as 15-20%.

Dr. Scott believes that rickets is diminishing in Glasgow, where it was formerly so prevalent that this city was regarded as the "home of osteotomies"; but Dr. Vincent, in his evidence, is inclined to doubt the accuracy of this statement.

Dr. Greenwood finds rickets very prevalent in Sheffield, and the number of deformed people something terrible. He does not consider that the disease is due to the mothers working in the factories.

Dr. Young does not find rickets so prevalent in Liverpool as in some of the other towns: he attributes this to the fact that there is not so much overcrowding, and to the better feeding of the people. He does not find it much amongst the alien population who are a fairly-good class, and mainly Poles and Germans. He finds more cases in Manchester than in Leeds, where there is more overcrowding of the inhabitants. In Manchester, in 1903,



there were 901 infants and children, out-patients, suffering from rickets in early stages; and 539 children over 3 - 4 years of age had such deformities as knock-knee and bow-legs (Ashby).

Hutchinson is inclined to believe that there is more rickets in Edinburgh than in London; but, judging by the records of Sir William Jenner and his own present observations, he is of the opinion that the disease is not on the increase.

In Boston, Morse states that 80 per cent. of infants attending the dispensaries showed signs of rickets.

In Russia, 95 per cent. of infants have rickets in a slight degree, and 35 per cent. are more severely affected (Jankowsky).

In Norway, Johannessen put the number of children with rickets, attending his clinic, at 32 per cent. He considers that the disease is most common from April to June, and less frequent in November and December.

### SEASON.

Most writers agree that rickets is much more frequently seen in the winter than in the summer months; but it is difficult to be accurate with hospital patients, for, as a rule, the attendances are far greater during the colder season.

Kassowitz notes that there are more cases of rickets in the winter, and that the type of the disease is more severe during the colder weather.

Rickets is more common in the winter because of the long periods of cold, with dark and sunless days, during which time the children are kept indoors - especially in the homes of the poor; where the fear of the open window is profound, they suffer from constant impure air and inadequate ventilation. By these means the general tone and nutrition of the children is lowered: they suffer from frequent catarrhs of the bronchi or gastro-intestinal tract, and thus the way is paved for the onset of rickets. A deficient supply of oxygen seems to be an important agent in the production of rickets; and it has even been suggested that imperfect oxidation of the blood - due to bronchial catarrh or collapse of the lungs - is the cause of the disease.

Edlefsen (Deut. Aert. Zeit., 1901, 1902), from an examination of the children in the clinics of Kiel and Hamburg, considers that the fact, that the number of cases reported in the first half-year increases steadily and reaches its maximum between the sixth and ninth month, justifies the theory that the disease is favoured by the winter climate, and also supports the carbonic-acid theory, because of the frequency during these months of diseases of the respiratory tract. Cases that are not explained by this cause he refers to the possibility of an infection.

Rickets is a common disease of the cities, the great manufacturing and industrial centres of Europe and America, where people live crowded together, and true domesticity is almost forgotten: for the wife most often is not engaged with homely duties, but goes out all day to work in the factories to gain more wages, putting aside all maternal duties, boarding out the unfortunate infant, or placing it in a crèche, until her day's toil is done, - so that it is seldom fed on the breast, but with bottles of inferior cow's milk or unsuitable patent foods. The

people live crowded together, the houses are badly attended to, and generally of very inferior construction and hygienic arrangements.

Rickets is a product of civilisation. It is less common in the villages than in the towns, because the infants are more generally nursed at the breast, and, even if the homes are scarcely any better, they are amongst better surroundings, the air is purer, and there is more out-door life, so that the growing children develop an increased power of resistance which will help to render them less susceptible to bad influences, and, even if artificially fed, they do not fall so readily victims to disease. Lack of fresh air, sunshine, and unhygienic surroundings, if not actual causes, undoubtedly strongly predispose to rickets.

Cheadle (Artif. Feeding) does not regard any as essential factors in the production of rickets, because he finds that children brought up in good homes, with excellent sanitary conditions as regards air, light, cleanliness and warmth, still suffer from the disease. He strongly maintains that these factors only degrade nutrition, and asserts that he had never seen a child develop rickets in the most unhealthy surroundings, if properly fed and free from dietetic disturbances.

Morse examined 318 dispensary babies in Boston, and concluded, after a careful study of nationality and food, that they had only one influence in common producing rickets, the same being unhygienic surroundings. It has previously been remarked that the principal apparent cause of rickets amongst the negroes and Italians in American towns is probably want of sunlight, coupled with deficient ventilation, though it is possible that the real reason is some degradation of nutrition.

The infant is very susceptible to cold: chills lower its vitality, and quickly cause disorders of the digestive tract or catarrh of the respiratory organs. The lower limbs are often bare, and especially amongst the children of the poor. If no napkins are worn, the winds blow up and strike the abdomen, which is frequently affected by the evil influences of chill and damp. The child spends a considerable time crawling about the floors, where cold air freely circulates in strong currents, carrying also many impurities from dust and debris, so that there is the double danger of chill and infection always present. The soles of the feet are particularly sensitive to cold and damp; and for this reason Angel Money describes them as external kidneys. Cold may easily cause impairment of health; and rickets may follow in the wake of malnutrition, or the lower vitality thus engendered. The coldness of the climate, the lack of out-door life, and the constant breathing of impure air appear to be the causes that diminish the resisting-power in the negroes and Italian races of America, and induce a special susceptibility to rickets in their infants.

A deficient supply of oxygen is an important factor in the production of rickets; and it has been suggested that imperfect oxidation of the blood, due to bronchial catarrh or collapse of the lungs, is the real cause of the disease. Excess of carbonic acid gas in the air has been advanced also as the cause of rickets.

Kassowitz (Deut. Aert. Zeit., 1903, No. 3) considers that inhaled organic matter (reichstoffe), crowd-poisons, and products of organic decomposition are the chief

causative factors in the development of rickets. This, he believes, will explain the smaller number of cases and their more favourable course, if present, in the country and high altitudes. The ammoniacal decomposition of urine furnishes such a causative agent, in which atmosphere children always acquire rickets in a specially severe form.

Sir T. Barlow and Judson Berry (Keating's Ency.) admit the influence of oversuckling, premature weaning, and unsuitable feeding in producing rickets, but consider that more attention should be paid to two other agents - viz., (1) bad air, and (2) the insufficient covering of the infant's limbs, as illustrated by the period of shortening and the mistaken idea of the process of hardening, which need only be mentioned to be condemned.

### SYPHILIS.

In 1881, M. Parrot advanced the theory that rickets was only a varied form of syphilis, and regarded the osteophytic and spongioid tissue as a common property of both diseases. He prefers not to regard rickets as a pathological entity, but simply as a modification of syphilitic osseous disease, and writes that "it is an old confusion to consider that it is rickets which absorbs the syphilitic alterations of the bone, but on the contrary that syphilis in its immense process includes (englobe) rachitis" (Trans. Path. Soc., Vol. xxx). He notes two characteristic lesions of the membranous bones, which he classifies under (1) atrophy, and (2) the production of new tissue.

These conclusions of Parrot are not generally accepted at the present day; the two diseases are regarded as distinct conditions, having some symptoms common to both; and it is admitted that syphilis may modify rickets. The fundamental difference between the two diseases is very great: for rickets is a cartilage-producer, whereas syphilis is the great producer of bone.

It does not follow that, because an infant is syphilitic, it will also suffer from rachitis; but, owing to the debility and the cachectic condition so often produced by congenital syphilis, it often contracts rickets as a secondary complication of the constitutional disease. The stigmata, the cicatrices of the buttocks, the lingual desquamation, the natiiform skull, and the eroded teeth may be met with in syphilitis and non-syphilitic children. Hereditary syphilis appears earlier than rickets, and is often a disease of intra-uterine life. In syphilis there is generally a history of previous miscarriages: as a rule, the firstborn is affected, though, if the mother is under treatment, the disease may only appear in the second child of her family. Rickets, as a rule, appears in the last children of a family, when the mother's blood is poor, and when she has been exhausted by pregnancies rapidly following one another, or by lactation during the gestation of another child. Syphilis is common to rich and poor: rickets is found most often amongst the children of the poor. Syphilis responds to treatment by mercury, and some authorities aver that this drug in a case of rickets is dangerous. Non-syphilitic parents may beget rachitic children, while those with syphilis may produce healthy progeny. The lesions of rickets tend to disappear after



infancy and childhood, but those of syphilis more often remain permanent, and can be detected in later life. Syphilitic children rarely present the spongy tissue peculiar to rickets, and rachitic bones seldom show the osteophytes so characteristic of syphilis.

Two signs are common to rickets and syphilis - craniotabes of the skull and fibrosis enlargement of the spleen: it seems probable that they are not found in a rachitic child unless syphilis is also present. Many authorities believe that craniotabes is always of syphilitic origin.

Barlow and Lees (Trans. Path. Soc., Vol. xxxii) investigated 100 cases. No less than 71 showed a marked degree of craniotabes, 30 only showed it in a slight degree; and the investigators decided that the presence of syphilis was conclusively proved in 47 cases. Out of the 47 syphilitic cases, 12 had slight and 35 marked craniotabes. Occasionally craniotabes seemed to be the last relic of a vanishing syphilitic dyscrasia.

Elsässer, who first described the condition, had noticed that craniotabes is apt to recur in two or more children of the same family; and Barlow and Lees verify this observation. They also observed it in a healthy well-suckled infant, and cite a case to show that it is not simply a condition of marasmus. They conclude that syphilis is by far the most important factor in the causation of craniotabes. After tabulating rickety symptoms associated with craniotabes, they endeavoured to define the relationship of one to the other by taking 53 cases between two and nineteen months of age:

- 11 cases exclusively breast-fed - no rickets.
- 1 case almost exclusively breast-fed - rickets almost nil.
- 14 cases partly suckled, partly fed - 9 had rickets.
- 9 cases suckled for part of a month or not at all - 6 showed commencing rickets.

They conclude that if craniotabes and enlargement of the spleen are removed from the category of rickety symptoms, there is no proof that syphilis, per se, is a cause of rickets. With reference to craniotabes, they consider that:

- (1) It is not common to pure rickets.
- (2) It is not at all special to rickets.
- (3) It is very common in congenital syphilis.

Dr. Gee has suggested that, if the rickets of the puppy and of the infant ~~is~~ the same disease, it would be a very great stumbling-block to the syphilitic theory of Parrot.

### TUBERCLE.

It has been asserted that tubercle has been rarely found in a rachitic child; but the statement must be accepted with some reservation.

Eustace Smith doubts the diathetic character of rickets, and remarks that "it never occurs in children, in whom the tubercular deposition is well-marked."

Holt does not consider that there is sufficient ground for believing that rickets exerts any protective action against tuberculosis, but that it is more probable that the thoracic deformity may be a predisposing cause

of the disease.

Sir William Jehner stated that rickets does not exclude tubercle; but a table, prepared for him by Dr. Edwards (Trans. Path. Soc., Vol. xxx), showed that the children of phthisical parents were less liable than those of non-phthisical parents to become rachitical.

Ritter v. Rittershain proved that a large proportion of the fathers of rachitic children were tuberculous.

It seems probable that rickets exerts no protective influence against tubercle; and, therefore, a child of feeble nutrition, with sunken chest and patches of collapse and emphysema in its lungs, readily affected by catarrh, bronchitis, or pneumonia, ought to fall a victim more easily to tubercular disease, and be a nidus for infection by its special bacillus.

#### MALARIA.

The symptoms of this disease are sometimes very indefinite - in infants, rigors ~~has~~ <sup>being</sup> replaced by a condition of pallor, drowsiness, general cyanosis and prostration (Holt).

This general marasmic condition of the child, coupled with enlargement of the spleen, may cause it to be mistaken for rachitis, with which, however, it has no association whatever.

## B A C T E R I O L O G Y.

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The disturbance of the young growing osseous tissue is comparable to the process of inflammatory reaction; and, because of its intensity and the manner in which it rapidly affects the various parts of the body besides the bones, it has often been suspected that some organism may be at work in the production of the rachitical dyscrasia.

The hyperaemia and the vascularity of the bones suggest that there is a toxin in the body which the blood is trying to overcome; and, therefore, many authorities consider that rickets is produced by the absorption of toxins from an unhealthy alimentary canal. There is a prodromal stage in rickets marked by indefinite symptoms of gastro-intestinal disturbance, dyspepsia, constipation (Jacobi), diarrhoea, general malnutrition, and debility. It may be that the special symptoms of rickets, - the sweating, muscular weakness, osseous lesions, laryngismus, tetany, and convulsions, - are the result of different, but allied, toxins (Ashby, - Ency. Med.). This would more readily supply a reasonable explanation for different parts of the body being affected at varying times: for, in one case, gastric symptoms may be predominant; in another, debility with great muscular weakness; whilst other cases point to slight or profound disturbances of the nervous system, - as evidenced, in slight degree, by sweating of the head and restlessness at night, or, in graver forms, by tetany, laryngismus, or convulsions. Such varied symptoms are more easily explained if it is assumed that various toxins, with different selective actions, are circulating in the blood; and the irritation of a certain organ of the body depends upon the nature of the toxin absorbed. Nevertheless, the result of investigations in this direction are neither satisfactory or convincing.

Mircoli examined the bones of rickety children, and found various pyogenic organisms - mainly streptococci and staphylococci - in the marrow; but the same organisms have been found in healthy bones, and inoculations with cultures of staphylococci and their toxins have failed to produce rickets.

Murpurgo claims to have discovered a specific organism, a diplococcus, with which he infected young rats and caused typical rickets; but other workers have been unable to confirm his experiments.

Spellman endeavoured to isolate a specific organism from the intestines of rickety infants; but his experiments met with no success. As diarrhoea is a frequent symptom of rickets, he tried the injection of an extract of the diarrhoeal stools of rickety infants into twenty-one rabbits and one cat; but in only one animal - a rabbit - was he able to cause any symptoms of rickets.

Kassowitz does not regard with any favour the theory that an intestinal toxæmia is the cause of



rickets, because intestinal troubles are more common in the summer, and rickets is a disease of the winter months. This objection loses very much in weight, when it is remembered that the onset of rickets is so slow and insidious that it can hardly be possible to affirm that the disease **did** not really slowly incubate during the summer months, when the various forms of gastro-enteritis were more prevalent, and that the real symptoms of rickets only developed many months after the intestinal toxæmia had done the harm. Our author himself apparently refutes his own objection: for he points out (Deut. Aert. Zeit., 1902, No. 3) that rickets does not flare up suddenly, as infectious diseases frequently do; and he further remarks that the beginning of the disease lies much farther back than the winter months, and must be sought for before birth, or in the first months of life. He has never seen cases in which an uncomplicated rickets suddenly appeared with febrile disturbances, and showing fever during the course of the disease.

Other experiments have been made with bacilli, but no positive results have been obtained: animals were fed with the colon bacillus, or their toxins were injected into their circulation; the toxins of the bacillus pyocyaneus have also been used in a similar manner, but with negative results in all cases. It is conceivable that it is not possible to cause rickets in a healthy animal, but that some disorder of the intestinal tract must be present to ensure the development of this disease.

Edlefsen (Deut. Aert. Zeit., xxii, xxiv, 1901; viii, ix, 1902), who believes that many of the cases of rickets are accounted for by cold and probably carbonic-acid poisoning, suggests that the infectious-theory would account for the repeated appearance of rickets in **certain** dwellings - particularly in those in which other sources of **infection**, - such as polyarthritides, pneumonia, and cerebro-spinal meningitis, - are found. It seems more probable, **however**, to the writer that the infection would supply an illness induced by microbes present in the bad air, drainage, or defective hygienic appointments, - and this, by leading to malnutrition in the child, would predispose to rickets.

We are not yet aware of the true nature of the disorders produced in the infant fed by artificial means, or of the toxins that may be absorbed into its system. It is impossible to form accurate conclusions from the experiments upon animals: for similar conditions, acting upon a child or an animal, may not give similar results. The effect of drugs on the human infant and on a rabbit may be very diverse; and, therefore, conditions causing rickets in a child may not be equally effective in the case of a lower animal.

Spelman subjected various animals to similar conditions which produce rickets in an infant - e. g., bad air, poor light, and inferior food: all died from gastro-intestinal disease within a few months, but none showed any signs of rickets.

When we get a clearer conception of the chemistry and the biological nature and the differences of the human milk as compared with that of **other mammals**, we may be in a position to discover a true toxin circulating in the blood of a rickety child.

All mammals suckle their young for varying periods, and their milk, besides affording nourishment, plays a definite part in the development of the digestive tract. Until lately, the comparison between mother's milk and cow's milk, or that of other mammals, was based upon the proportion of the chemical constituents - the proteid, fat, carbohydrates, and salts; and all attempts at preparing an artificial milk were governed by the idea that the percentage composition of the modified milk should correspond, in all particulars, as closely to maternal milk as possible. It was presumed, therefore, that dilution of proteid, with increase of fat and sugar, when dealing with the milk of the cow, would produce a mixture almost identical with mother's milk. Later, it was found that the proteids of all milks differed, the reaction to rennet and acid-producing curds of different nature and consistency, - some tough and leathery, and others light and flocculent. The chemical character of the proteids contained in the curd was also found to vary in the different species of mammals.

Milk is to be regarded as living fluid, - passing from the mother to the child, in order to assist in its nutrition and development, - which contains all the elements necessary for growth, together with various ferments and protective agents, the nature of which we are only able to speculate about until our knowledge of them is more certain than at present. The differences in milk are not so much chemical and nutritive as physiological.

Though separated from its mother at birth, a child should still be considered a part of the parent until it arrives at the age of weaning. It should derive sustenance from the body of the mother, and should not be regarded as a separate individual until it is able to digest the food suitable for an adult animal. "Physical separation takes place at birth, physiological separation at weaning" (Chapin).

The human infant is the most helpless of mammals, the higher brain centres are immature, and, unlike the young of many other animals, it is unable to walk or feed itself. Yet, unfortunately, it is the mammal most often deprived of its true maternal sustenance, and fed on compounds badly adapted to its undeveloped stomach. From the physiological standpoint, an artificially-fed baby is an immature child, and only the milk of its own mother is adapted to its digestive tract. Any milk, other than human milk, may prove a veritable poison.

The real difficulty that arises, in the feeding of infants on cow's milk, is that the digestive tract of the calf and the infant differ, and that physiologically cow's milk is only suitable for the stomach of the calf, and mother's milk for the stomach of the infant. This also applied, more or less, to the milk of other mammals.

Dilution of cow's milk, so-called humanising, - the addition of lime-water, alkalies, citrate of soda, or dextrinised gruels, - will not convert cow's into mother's milk, though it may modify the action of the gastric juice upon the curd.

The development of the calf is more rapid than that of the human infant: a calf doubles its weight in forty-seven days, whilst an infant requires one hundred

and eighty days. The milk of the cow contains 3 per cent. of proteid to assist in the rapid growth, whereas the maternal milk, because the development of the child proceeds more slowly, contains only 1 per cent. of the proteid element. The calf, even when a few hours old, is able to chew the cud, and thus further digest it; the unfortunate newborn infant, nurtured on cow's milk, has not this advantage, - and so the solid tough curds must remain in the stomach, or be passed on until digestion thereof is accomplished.

Nature did not intend the infant to take any food, except breast-milk, until the digestive tract is fully formed; and the maternal milk assists in the proper development of its stomach, and supplies the digestive juices to deal with the ingested milk. An artificially-fed baby starts badly handicapped in the race for life, as it has to deal with a food-substance intended for another animal, - so that the result may be a defective functional development of its alimentary tract, with constant irritation of the delicate tissues leading to chronic indigestion and malnutrition. Toxins, foreign to the infant, may be formed by the cow's milk, or by the artificially-prepared foods; and the epithelium of the alimentary canal, damaged by chronic catarrh, may allow these to pass into the blood, and by their irritant action on the tissues, set up inflammatory reaction, thereby producing the disease of rickets. The milk of the cow may be poisonous in the case of the infant.

During the course of certain diseases, - such as typhoid, tetanus, diphtheria, - the blood of animals and mankind produces antitoxins to enable them to fight successfully the toxins introduced by the bacteria present in the system. Each disease gives rise to the production of the special antitoxin, which will react against the special toxin then present in the body. It is not a disease of microbic origin alone that is able to cause this peculiar reaction of the body leading to the production of antitoxins, in order to fight successfully the toxins circulating in the blood.

Cow's milk, when injected into an animal, is able to produce in the serum of that animal the power to bring about a precipitate when added to fresh cow's milk; but this does not occur if the serum of the infected animal is mixed with the milk of the mare or woman. In the same way, if cholera bacilli, a bacterial-free filtrate of typhoid or spermatozoa are injected into a guinea-pig, the serum of that animal will give a similar reaction. The serum only agglutinates with the injection employed, bacteria, bacterial-free filtrate, or spermatozoa - according to whichever has been used in the experiment. Therefore, the injection of milk, spermatozoa, bacteria, or their toxins produces a similar reaction in the serum of mammals, - and thus the inference is that the milk of the cow, the spermatozoa, or the bacterial toxins can all be classed as poisons, under certain conditions, of the organism. Intravenous injections of cow's milk are able to lower the leucocyte-count in the blood; and, if the injections are often repeated, will cause the death of the animal. The albumin of one animal will act as a poison to any other animal; and all these



substances, to safely support life, must first pass through the intestinal canal, and be dealt with by the digestive fluids - otherwise they may act as poisons.

The intestinal canal has the power of protecting the body, and prevents the absorption of foreign albumins until they are being acted upon by the digestion. The albumins are acted upon by the ferments of digestion, and it is shown that they are no longer toxic: for, if milk or egg-albumin, previously digested, are now injected into an animal, they are no longer able to cause the appearance of antitoxins in the blood. The proteid of the cow must be digested, or converted into human proteid, before it can be used with safety as a food by the infant. The epithelium of the gastro-intestinal canal has the special power of being able to deal with the albumins of different animals; but all other cells of the body can only use with safety a proteid of their own species - all other proteids acting as poisons.

It is therefore evident that, whereas the infant suckling at its mother's breast is able to assimilate without change the human proteid taken into its stomach, the infant, artificially fed upon cow's milk, is first obliged to transform the proteid of the cow into the human proteid before it can safely pass out of the stomach into the circulation. This means that, in a rudimentary condition and with intestinal cells poorly developed, an alimentary canal is called upon to perform extra work at each meal taken by the infant; and, with the ever-present danger added, that any failure of its functions may lead to the absorption of toxic substances: for the other cell-tissues will react to the albumin of the milk of the cow, if unconverted into human proteid, as if it were a poison. Under ordinary circumstances, no toxic products are allowed to pass into the circulation: for no antibodies are found in the blood; but, if cow's milk is injected subcutaneously, antitoxins are always formed.

Experiments of Ehrlich and Salge tend to prove that the mother is able to pass the antitoxins present in her milk over to the suckling child, but that the antitoxins of another animal are not thus conveyed.

Moro's investigations (Jahr. f. Kinderh., Vol. lv, 1902) also support this theory. He was unable to find bactericidal activities in human or cow's milk; but he ascertained that the blood-serum of breast-fed children has much greater bactericidal and haemolytic powers than that of bottle-fed children. He attributes this to the presence of alexins in the human milk; and, although these cannot be demonstrated, he believes that they are derived from the blood-serum of the mother, and combine with the casein by the action of cells in the mammary gland. This, he considers, emphasizes the great importance of breast-feeding; and he quotes Favorinii's aphorism, that "a woman is the complete mother of her child only when she herself suckles it."

The advantages that accrue to a breast-fed infant are far deeper, and more potent, than those merely derived from the digestion of a food of definite chemical composition and of easy digestion. The breast-fed child is taking a food chemically and biologically

suitable for the development of its gastro-intestinal tract, ready for almost immediate assimilation, non-poisonous to its tissues, and containing the antitoxins of its mother's body: the bottle-fed infant, brought up upon cow's milk or on artificial foods, is nourished by a substance that may have the same chemical elements in its composition as human milk, but with the atoms differently arranged, and possessing a biological action intended for use by another animal. It is not readily assimilated, however: for (if a milk) it is intended to develop the alimentary canal of an animal whose ratio of growth is more rapid than the human child. It is poisonous to all cells of the human body, except the intestine, and, when acted upon by the digestive ferments, it must first be converted into human proteid before it can be absorbed with safety into the system. Furthermore, although possessing antitoxins for its own species, it is unable to transfer any of them to the body of the human infant. Therefore, an artificially-fed infant is always being nourished under terrible disadvantages; and, unless its food and hygienic surroundings are very carefully supervised, it is liable, at any time, to suffer from digestive disorders, debility, and malnutrition. It is well known that the rickety infant frequently has a dilated stomach, associated with deficiency of hydrochloric acid. If the stomach is unable to secrete sufficient hydrochloric acid, the pepsin will not be liberated, and there will be an interference with the digestion of the rennet-curd.

Previous catarrhs of the stomach and intestines may have weakened the epithelium, thereby allowing albuminous products unacted upon by digestive ferments - and therefore poisons - to pass into the circulation. These toxins, possibly with different selective actions, would cause irritation of the various organs of the body, and, by attacking the young and active cartilage and periosteum, interfere with the osteogenetic tissues, and cause defective ossification of the bones. The absorption of toxins from the milk of the cow, possibly as albumin, may serve to explain the cause of rickets.

The fact that rickets is curable by fresh air, good hygienic conditions, and the addition of fat and proteid to the diet, with careful attention to the digestive tract, does not altogether disprove this theory. For, under the bettered conditions, the leucocytes of the blood could deal with the toxins present in the system, the irritation of the tissues would lessen, and eventually there would be recovery from the disease. The epithelium of the digestive tract, repaired and in healthy condition, is then able to deal with the proteid of the cow, and convert it into human proteid, - thereby preventing any further absorption of toxic material. The food will be thus assimilated with repair of damaged tissues, and growth and development of the human organism proceed on normal lines.

Though this theory is open to much criticism, the writer feels that this is a possible path along which the true etiology of rickets may be found and studied in the future. In these days of antitoxic sera, one even speculates on the discovery of an antirachitic serum, though, if mothers could only be taught how wonderful and valuable their breast-milk is to the infant and how irreplaceable, it would not be necessary to provide any artificial aids for the healthy development of the human child.



B. Murpurgo (Gior.d.R.Accad.d.Med.d.Torino; Brit. Med.Jour., Aug 4, 1901, Epit.) has, for the last seven years, made experiments on 300 white rats, by infecting them with material derived from other white rats which showed signs of rickets or osteomalacia. The results of these experiments demonstrate that, if a healthy young rat is infected with material derived from a white rat suffering from osteomalacia of apparently spontaneous origin, it frequently develops rickets; but, if an adult white rat is infected in a similar manner, it develops osteomalacia. Rickets may be acquired, by healthy young rats, by simple contact with white rats suffering from rickets or osteomalacia. Murpurgo has been unable to produce osteomalacia in a healthy adult rat through contact with a rickety young rat. The source of infection is a bacterium of variable virulence, and it is possible to cultivate it outside the body of the rat. If the bone is in a condition of active growth, the organism produces changes in the epiphyseal cartilage comparable to human rickets; but, at a later stage when growth in the bones has ceased, it causes softening and rarefaction of the osseous tissue.



## P A T H O L O G Y.

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The main pathological condition in rickets may be summed up in the aphorism of "an exaggerated preparation for ossification, and a diminished accomplishment of it!"

The principal changes in rickets are seen in the bones, though all the organs of the body suffer to a certain extent - the effects of the same, however, not being so evident.

The changes in the long bones are swelling of the epiphyses, thickening of the periosteum, decrease in the lime salts, increase of the medullary tissue, - which is soft and resembles gooseberry-jelly, - with general softening of the bones. In the later stages the bones become bent and distorted, and fracture - especially greenstick - may occur. As the disease tends to recovery, there is consolidation and eburnation of the bones, which may finally become much harder than normal. Often the individual is permanently dwarfed, and the remains of the disease persist throughout life in the bossed head and thickened joints, though frequently recovery may take place leaving no trace of the disease behind.

The long bones grow in length by the production of osseous material in the cartilage between the epiphyses and shaft; in thickness, by the production of bone beneath the inner layer of the periosteum; and the medullary cavity is formed by absorption of the inner layers of bone. In rickets, all these conditions are perverted: for there is an exaggerated production of cartilage at the epiphysis, an excessive growth thrown out under the periosteum, and the act of ossification is arrested or imperfectly performed. The inner layers of bone are absorbed more rapidly than normal, - so the medullary cavity is large and full of spongy tissue. The bone, even when formed, is very imperfectly calcified.

The active agent in the growth of a long bone is the diaphyseal cartilage, which passes through two intermediate stages, chondroid and spongoid, before normal bone is finally manufactured. It is a layer of hyaline cartilage which separates the body of the bone from the head. This thickens, proliferates, and a spongy layer is formed with fine delicate trabeculae running through it. Between the diaphysis and the intermediate cartilage is a layer, the chondroid layer, measuring  $\frac{1}{2}$  - 2 mm. in thickness. It consists of primary cartilaginous capsules in which ~~the~~ parallel rows of secondary capsules, separated by layers of granular substance (Rivulations of Broca). In these intermediate rivulets the deposition of lime salts first takes place, then in the primary capsules, and finally ~~the~~ secondary capsules dissolve and break down, - so that their contents mingle in the primary capsules, and the calcified partitions are absorbed (Spongoid Layer). This is proliferated, and ossified; cartilage-vessels penetrate the layer, canaliculi are formed, and thus is reached the final stage in the manufacture of bone.

In rickets the process is perverted, so that, instead of normal bone being manufactured, the last stage is interfered with or arrested, and inferior material is produced. There is overactivity of the proliferating cells of the cartilage, and, instead of calcification taking place, the tissues become exceedingly vascular, with large spaces filled with red jelly-like marrow instead of normal bone. To the naked-eye there is thickening epiphyses of all long bones - especially the radius and ulna. The width of the epiphyses may be increased one-half; and all the angles, borders, and sharp prominences of the bones are rounded off. The bones are unusually flexible, and bend under the weight of the body.

Guérin describes four stages:

- (1) Effusion and rarefaction.
- (2) Deformation with organisation of effused material.
- (3) Consolidation and eburnation.
- (4) Rarely consumption.

The chondroid layer, which under normal conditions is  $\frac{1}{2}$  - 2 mm. in thickness, in the rickety bone is as much as 4 - 12 mm. thick, and also bluish-gray, swollen, and spongy in appearance. On one side it blends with the cartilage of the epiphysis, on the other it presents an irregular and **denticated** border. There is excessive activity of cartilage, the spongioid tissue pushes up in an irregular manner, and it is difficult to distinguish spongioid and chondroid tissue. Patches of one tissue are found isolated in the tissue of the other, - so that calcified areas may be seen in parts which are cartilaginous, and islets of cartilage are found in places where complete calcification should have occurred. The secondary capsules do not dissolve but calcify, the blood-vessels enlarge and anastomose freely, and the interspaces are filled with gelatinous marrow instead of normal bone. The cartilage may be transformed into inferior bone. In this spongy bone there is thickening and erosion of the bony trabeculae, thus forming large medullary spaces filled with blood-vessels and connective tissue. The medullary spaces are continuous with the channels of the shaft, and a tissue, spongy and vascular is thus formed; the areolar tissue is dilated, and full of blood-stained jelly, which has been compared to gooseberry jam. The medullary canal is also full of a highly vascular and gelatinous material.

The periosteum passes through similar stages: the proliferating layer is formed in excess of requirements, and at the same time there is defective ossification. The outer fibrous layer of the periosteum is thickened, vascular, and adherent to the roughened bone; the inner layer, in which the bone is formed, is over active; and the exudation first forms connective, and afterwards osseous, tissue. This subperiosteal bone is five or six times thicker than normal; but it is poor in quality, spongy, and deficient in lime. The dried bones are porous, friable, decalcified, and very light in weight. They are soft and flexible, bending under the body-weight or traction of the muscles. The thickening and vascularity of the periosteum is more marked on the concave side of

the bending bone, and it is also more adherent than on the convexity. The tissues of the bone resemble a sponge or biscuit; the lime salts are absorbed, and fibrous tissue takes the place of normal bone. This is Guérin's stage of deformation and organisation.

In from three to fifteen months, the active proliferation of cartilage and periosteum ceases, the bone gradually becomes less vascular, and ossification takes place in the normal way. As soon as the rachitis subsides, the bone is in a suitable condition for ossification. The new tissue beneath the periosteum, and between the diaphysis and epiphysis, organises and becomes calcified. Sometimes this ossification occurs so quickly that the growth of the bone is cut short; but the bone now formed is very dense, and as hard as ivory (eburnation). The bone also tends to become straight, and the nodosities disappear. This is Guérin's stage of consolidation, with repair and organisation of destroyed tissue and final aburnation of the bone.

Occasionally, however, repair does not take place, and there is no consolidation of the tissue. The bones then remain fragile and light, with the spongy areolar tissue filled with fat. This is the stage of consumption.

Very often the active process ceases when the child is two and a half years of age, and, if then examined, it will be noted that the swelling at the epiphyses is diminishing, the curvatures, if slight, may have disappeared, the beadings of the ribs are not perceptible to touch, and the bosses of the head have shrunk. On the other hand, a great deal of the deformities may remain permanent, and the child grow up a rickety dwarf.

Trousseau emphasizes the fact that the bones of a rickety skeleton are very light. A rachitic femur, even after consolidation has taken place, weighs less than normal. The skeleton of a normal child weighs 7 - 8 kilograms, and that of a rickety individual may only weigh one kilogram.

The bones are soft and flexible, being easily cut with the knife, and are readily bent or fractured. The fresh bone formed is deficient in lime, and such bones yield less gelatine on boiling (jenner).

#### CHEMICAL CHANGES.

In the normal bone there are two-thirds inorganic matter, and one-third organic matter; but, in rickets, the proportion is reversed, and there are now one-third inorganic and two-thirds organic matter. The deficiency is mainly due to the absorption or removal of phosphate of lime. The actual proportions are generally stated thus:

	Inorganic.	Organic.
Normal .....	63	37
Rickety .....	79	21

Kassowitz considers that lack of lime is not due to absorption, but to a defect in deposition of that substance.

#### FLAT BONES.

In these bones also is seen the condition of perverted ossification, delay, atrophy, and hyperplasia.

The Skull.— The change observed in connection with the skull is very marked, and supplies one of the characteristic signs of the rachitic disease, namely,



the large bosses or protuberances due to the thickening of the bone about the centre of ossification, and generally on the frontal bones. These bosses are soft, spongy, and exceedingly vascular, and are generally developed on the outer table of the bone. On section, it is at once noticeable that the trabecular spaces are much increased. The bosses are large and spongy masses, soft, easily indented by the finger, and under this pressure there oozes out freely a discharge of blood and serum. As a rule, these bosses remain permanently, and are characteristic features of a rickety skull, though they tend to organise, and more rarely are completely absorbed without leaving a trace behind.

Another cardinal symptom frequently observed is the patchy thinning of the membranous bones first described by Elsässer, and named craniotabes. In this condition the margins of the bone are thin and remain membranous; and in parts there is marked thinning of the inner table of the skull, which, to the touch, gives the feel and crackle of parchment. It is especially seen in the parietals, occipital, and sometimes the temporal bones. The most characteristic patches are usually in the centre of the bone, and are due to defective calcification, while in some places the bone consists only of membrane.

The Ribs, Clavicles, and Spine.—The beading of the ribs, or the "rickety rosary," is often the first noticeable sign of the changes going on in ~~the~~ the skeleton of a rachitic infant. The rosary consists of nodules which can be felt at the junction of the costal cartilage and the bone. The beads have been detached at birth, and even in the foetal skeleton. They are most readily found in the lower ribs, and are more prominent on the inner surface of the bone.

The clavicles are thickened and twisted; and sometimes there is distortion of the scapulae.

The spine, owing to the lax condition of the muscles and ligaments, is curved. The characteristic deformity in rickets is kyphosis, most usually in the mid-dorsal region, and the curve is more frequent towards the left than towards the right side of the body (Holt).

The Rickety Pelvis (After Milne Murray).—The pelvis, supporting the weight of the trunk, often suffers severely, and the deformity adds considerable difficulty and danger to child-bearing in adolescent years.

The sacrum sinks down towards the pubis; and, at the same time, counter-pressure from the acetabula forces the pubic rami upwards. Consequently, the brim becomes kidney-shaped. The bones become hard in after-life, and this shape is permanently maintained. There is partial rotation of the sacrum upon itself; the prominence comes farther forwards, and the coccyx is pushed backwards. As a rule, the sacral hollow is largely abolished, and the anterior-posterior diameter at the outlet is largely increased. The pubic arch is widened, and the ischia diverge. The backward movement of the coccyx is sometimes checked by the great sacro-sciatic ligaments, — so that, whilst the sacrum goes back, the coccyx is pulled sharply forward.

#### TEETH.

The temporary teeth are late in appearing; they are poor in structure, and suffer from early decay. The permanent teeth also are often affected by rickets. The

dentine appears to be normal; but the enamel shows, in the parts earlier laid down (the parts nearest the dentine), defects in calcification, with cavities almost microscopic in extent.

#### MUSCLES AND LIGAMENTS.

The ligaments and muscles are affected by the general malnutrition of the body. They yield under the weight and pressure of the body, and the tension of the distended ~~intestines~~ causes diastasis of the abdominal recti, and the typical "pot-belly" of rickets is observed. Microscopically, the striation of the muscles is blurred and indistinct.

#### V i s c e r a .

Although, at first sight, the chief pathological changes seem to lie in the bones, on closer investigation it is noticed that nearly all the organs of the body are affected by rickets. The change in most of the organs is of the nature of a fibrosis.

#### BRAIN.

Formerly, the rachitic infant was supposed to have a larger brain than normal. This, however, is not the case. The skull, indeed, is increased in size, but this is due to the thickening of the bones; the brain, however, so far as size is concerned, remains unaltered. Some authorities consider that the brain is smaller than normal, or, if large, consider it to be due to fibrosis, or to associated hydrocephalus with the effusion of fluid into the ventricles.

Jenner alludes to a so-called hypertrophy of the white matter of the brain - "albuminoid infiltration".

Dr. Gee considers that the brain is dwarfed in rickets; and a cerebritis has sometimes been observed.

#### LUNGS.

Owing to the pressure of the shrunken thoracic walls, those portions of the lungs lying beneath the lateral furrows are in a condition of collapse, and those parts of the pulmonary tissue anterior to the collapse suffer from compensatory emphysema. The areas of collapse are always very markedly increased if the child suffers from whooping-cough or broncho-pneumonia; and these affections are particularly liable to prove fatal in a case of rickets.

Bronchial catarrh, bronchitis (acute and chronic), and broncho-pneumonia are exceedingly common in rachitic infants.

#### STOMACH.

The stomach is frequently dilated; and there is generally some evidence of gastro-intestinal catarrh.

#### LIVER.

The liver is usually depressed downwards, and is enlarged - though the enlargement may be more apparent than real, owing to its altered position and its prominence as an abdominal organ. There may be a condition of congestion, set up by the defective circulation of the blood through the lungs and the enfeebled action of the heart. There is no amyloid degeneration of the liver.

It has been suggested that some irritant, circulating in the blood, causes the disease of the liver and of the bones.

#### HEART.

The depression of the thorax pushes the apex of the heart outwards and towards the left. A white patch of thickened tissue is formed on the pericardium, where

it rubs against the beading of the ribs. In rickets this is seen on the left ventricle, whereas the white friction-patch, caused by the straps of the soldier's knapsack, is on the right ventricle.

#### SPLEEN.

The spleen is frequently enlarged. It suffers from a general fibrosis, the cells are often increased in number, and there is a decrease of earthy salts. Formerly, the spleen was supposed in all cases of rickets to be enlarged, but it is now known that this occurs in only a small percentage of cases.

Sasuchin found that, out of 66 cases, the spleen was enlarged in 12 - 15 per cent. The changes consisted of thickening of the capsule, proliferation of connective tissue, arteritis, thickening of the walls of the arteries, atrophy and obliteration of the Malpighian bodies, and anaemia of the organ.

The spleen may be increased two and a half times its natural size (Koplik); but Hutchinson (Diseases of Children) does not think that the organ is enlarged in more than 5 per cent. of cases - i. e., an enlargement sufficient to enable the condition to be felt.

John Cowan and J. Campbell McClure (Brit. Jour. Dis. Childn., Aug., 1906) examined 417 consecutive cases of rickets, in every stage of the disease at the Royal Hospital for Sick Children, Glasgow, and only found the spleen palpable in 17 cases, giving a percentage of 4.07; and they conclude that the enlargement of the spleen in rachitis is due not to the disease, but most commonly to splenic anaemia or congenital syphilis associated with it.

#### BLOOD.

The changes in the blood resemble those found in anaemia, if studied in an ordinary case of rickets. The red cells are not diminished in number; but some nucleated red corpuscles may be found; and there is a deficiency of haemoglobin.

The haemoglobin-index is from 51 - 75 per cent. In cases with complications, the blood shows the changes of secondary anaemias; there is low percentage of haemoglobin, reduction of erythrocytes, some leucocytosis due to excess of lymphocytes, and slight eosinophilia.

Broadly, it may be stated that the changes in the blood point to a malnutrition of the blood-forming organs.

#### THEORIES AS TO PATHOGENESIS.

Kassowitz regards the pathology of rickets as inflammatory, and believes that the primary disturbance lies in the hyperaemia of the cartilage, periosteum, marrow, and bone; also that the changes in the viscera are secondary to this condition.

Glisson attributed rickets to disturbed nutrition by arterial blood, and considered the excessive vascularity accounted for the changes in the long bones.

It is probable that there is some irritation, the exact nature of which is obscure, causing an overgrowth of the sensitive bone-forming tissue. The deprivation of lime is a secondary condition, and is not the actual cause of the rachitic disease. If the irritant acts suddenly or profoundly, - and thus interferes with the



process of assimilation,- the disease produced may be atrophy and not rickets (Keating).

The nature of the irritant is yet to be determined; it may be caused by decomposing food, by microbial agents, or by some chemical action in the tissues. But it seems certain that any injurious influence or depression of vitality,- such as improper food, damp, or want of sunlight,- will give rise to a rapid development of the irritant during infant life.

# SYMPTOMATOLOGY.

## INTRODUCTION TO SYMPTOMATOLOGY AND PREMONITORY

### SYMPTOMS.

In the early days of its existence, the human infant is in a very helpless and ill-developed condition, and, for the first few weeks of life, has no power of voluntary movement, nor does it possess any will of its own. Its actions are entirely reflex; it cannot perform any instinctive movements like the young of other animals; it is unable to hold up its head, or to walk or feed itself, until it has had several months of separate existence. But, during the first year, development takes place with sufficient steadiness and regularity to enable us to mark out definite periods and dates, in which to expect the appearance of physical and mental signs indicating growth and increasing vigour of body and mind.

The infant should be able to hold up its head between three and four months of age, to sit up between the ninth and twelfth month or even earlier, to stand and walk between the twelfth and eighteenth months, and to talk - in a more or less babyish fashion - by the end of the second year. The weight of the child should show a definite and progressive increase week by week; it should double the weight registered at birth by the fifth month, and to treble it by the fifteenth month of its existence.

Two other signs should be looked for carefully, as denoting normal progress - viz., the appearance of the teeth at regular well-known intervals, and the closure of the anterior fontanelle.

The first tooth should be cut between the sixth and seventh months, and all the temporary teeth should be visible by the end of the third year. The anterior fontanelle usually closes between the eighteenth month and two years: if it is not closed at two years of age, the child cannot be in a normal state of health.

Hutchinson aptly alludes to certain of these signs of development as "milestones"; and this name serves to impress on the memory the importance of knowing that, at given dates, a child should have progressed to certain points along the journey through life. He mentions three milestones:

- (1) The age at which the child cuts its teeth.
- (2) The closure of the anterior fontanelle.
- (3) The normal time for the assumption of the erect posture.

Growth and development are proceeding rapidly during the first year, but are easily hampered or set back by very slight causes. An acute illness, a chill, an attack of diarrhoea, - lasting perhaps only a single day, - may cause an infant to lose weight rapidly and prevent it from gaining ground for many weeks. In the

rachitic state, all processes of development are retarded: the teeth appear late and in irregular order, the anterior fontanelle remains widely patent for a period often extending over many years; and the assumption of the erect posture, and the acts of talking and walking, are so long postponed that even paralysis or mental deficiency may be suspected, as causes of the child's backwardness. The rachitic child is late in reaching all the milestones aforesaid.

It is of the greatest importance to watch carefully the child during the first year of its existence, and to note its development and any deviation from the normal; its weight and its general muscularity should be noted week by week; the appearance or non-appearance of the teeth at regular dates should be watched for; and the ability of the child to pass the milestones, which indicate the gradual increase of the muscular and mental power, must be closely observed as it advances into its second year. If this is systematically carried out, the observer can detect readily any retardation of development, and, often before actual symptoms appear, will be able to recognise the insidious onset of rachitic disease.

Rickets is a disease that slowly affects the nutrition of the child, possibly acting as a poison by gastro-intestinal or other form of intoxication, - so that the early symptoms may be misleading or slight; and it is only when the disease begins to show its evil effects upon the osseous system that its presence can be definitely recognised. But, during the first two years of life, if rickets is present, it is readily seen that some element is at work interfering with nutrition and retarding development. The child does not reach the milestones at its normal age, and this should immediately cause the observer to look for minor symptoms of the disease. Rachitis must be carefully distinguished from mere atrophy: for these atrophic infants seldom become rachitic. Many rickety children are big and fat, and their weight may be above the normal standard. If, however, the muscles are soft and flabby, the child anaemic, its digestion frequently disturbed by constipation and diarrhoea, or if it suffers from repeated colds, bronchial catarrh or bronchitis, a suspicion that an early stage of rickets is present may be reasonably entertained.

Though rickets is a disease of slow and insidious onset, there are no symptoms that can be definitely ascribed to the disease alone. One of the first signs of rachitis is an anaemia present in an otherwise well-nourished infant, and generally there is also a great enfeeblement of the muscular system. The child is unable to sit up or to hold its head erect; there is a tendency for slight curvature of the spine; and, though the legs are apparently well developed, it does not seem able to stand, or, if it is able, it soon gives up doing so and relapses into a lethargic condition. The weakness of the muscles and the atonicity of the abdominal walls early leads to a feeble muscular action of the intestines, and there therefore is little power of peristalsis, distension of the abdomen, and constipation. Constipation



in the early months of life, even in breast-fed infants, is to be regarded as a possible symptom of rickets. There may also be symptoms of gastritis, vomiting, diarrhoea with foul motions, together with frequent attacks of flatulence and colic. Carmichael includes frequent micturition as an early indication of the rachitic dyscrasia. These cannot be classed as true prodromal symptoms, but they indicate some disorder of nutrition, due to faulty diet, cold, or bad hygiene. Nevertheless, it is important to lay stress upon them; but, if neglected, they may merge later on into rachitic disease.

Other causes, however, may show no impairment of the digestive functions, but suffer from frequent catarrhs of the bronchi and lungs. These attacks may first draw attention to the general condition of ill-health present; and all catarrhal affections of the respiratory tract, during the early months of infancy, should be carefully treated, or guarded against, lest they lead on to malnutrition and rickets at a later date.

In other cases, again, the first symptoms appear in the nervous system, and are often ascribed by the family to worms or teething. The child may appear out of sorts, irritable, peevish, and constantly whining, as well as restless at night; and it may even suffer from convulsions or laryngismus stridulus, though the latter disease is not common before the end of the second year. The restlessness may be very largely set up by flatulence and indigestion, or it may be that the bones and muscles ache; but, if there is any acute tenderness, it should arouse a suspicion of the presence of scurvy.

There is one symptom that may almost be regarded as a classical one of rickets in the early stage, and that is profuse sweating of the head and neck at night. The child sweats profusely about the head and neck; and the perspirations of rickets can be distinguished from those of general debility by the fact that they are confined to those special parts of the body, leaving the trunk and extremities unaffected: whereas, in general debility, the sweating breaks out over the entire body. The skin, being soft, is easily irritated; and there may be erythema, intertrigo, or crops of miliaria. At the same time, the child is particularly restless; it constantly kicks off the bedclothes, even on the coldest nights. A rickety infant is notoriously a bad sleeper. During its restlessness the child rubs the back of its head, to and fro, on the pillow, and thus wears off the hair covering the occiput. This bald patch is regarded by many writers as one of the definite early symptoms of rickets. In addition to the rolling movement, the child may indulge in head-banging, or it may bore its head into the pillow, in a manner almost suggestive of meningitis. It sometimes sleeps in extraordinary positions, and may awake screaming: for, owing to its bad digestion and irritable nervous system, the rickety infant is a frequent subject of night-terrors. These symptoms are usually noticeable during the fourth to the sixth month, and are present long before the softening of the bones or the deformities give warning that the disease has been in the system for some time, and is making further progress.

Between the sixth and seventh months the failure of the lower incisor teeth to appear should warn the

attendants of the child that possible malnutrition or retarded development is present, and this danger-signal should not be disregarded. If, during the next few months, no teeth appear, or are few in number and cut in an irregular manner, the diagnosis that the child is rickety can be made with considerable confidence. In some cases the two lower central incisors may be cut at the proper time, and then no more teeth appear until the child has long completed its first year.

About the age of six months, spots of softened bone (craniotabes) may develop on the occipital, frontal, and parietal bones, but they cannot be regarded as solely of rachitic origin. They are only referred to at this juncture, as they may be an early symptom; they will be more fully when dealing with the other characteristics of the rachitic skull.

After the early symptoms have continued for some months, the effects of rachitic disease upon the osseous system begin to be manifest. The earliest signs apparent are the beading of the ribs, the sinking-in of the chest wall laterally, and the thickening of the epiphyseal cartilages of the extremities.

As a rule, the beading of the ribs closely follows the prodromal symptoms referred to the digestive, respiratory, or nervous systems, and is the first definite indication of the onset of the stage of deformation. The beading consists of thickened nodules on each side of the chest, forming, when viewed collectively, the characteristic rachitic rosary. At first, the beading can only be detected by careful palpation with the fingers, but, with the slow progress of the disease, the thickened nodes become more prominent, and can be recognised very easily with the naked-eye. These beads, or nodes, are the result of a hyperplasia taking place at the junction of the ribs with their cartilages. They are best seen on the lower part of the chest between the fourth and the ninth ribs. Post-mortem examinations have shown that the thickening is even greater on the under surface of the ribs, and they may cause, by pressure on the outer surface of the lungs, small patches of collapse in these organs. The beading of the ribs has been observed at three months, though at this age the nodes are seldom massive; and they have been identified in the infant as early as one month, and also found on dissection in a newborn child. The beads increase in size up to the end of the second year, and then slowly diminish and disappear. They are rarely found after the age of five years, and it is impossible, even though rachitic deformities are permanently present, to detect them in adult life.

The chest wall of the infant being soft, and without rigidity or elasticity, is sucked in on either side of the sternum during inspiration, and also by external atmospheric pressure. The vertical and lateral grooves, so marked a feature of the rachitic thorax at a later stage, - begin to make their appearance in the early months. If much bronchial catarrh is present, there may be localised patches of atelectasis and emphysema, the same being scattered throughout the lungs.

Another very characteristic and important sign in early rickets is the thickening of the epiphyseal cartilages - especially at the wrist and ~~ankle~~ joints. It is caused by the thickening of the line of ossification, and indicates disturbance of the normal ossifying cartilage. As a rule, the beading of the ribs can be detected at an earlier stage than the thickening of the epiphyses. But both phenomena appear early in the course of the disease, because rickets attacks the parts of the bone in which the development is in a state of most active progress, and it interferes with the formation of normal osseous tissue. The bulging appearance of the thickened epiphyses is a marked feature of the disease; and the wrist and ankle joints are generally loose and flail-like: for their ligaments are weak, flabby, and easily stretched by the movements or by the weight of the body.

After the first year the deformities of the skeleton become more apparent; and these will be considered in detail under the heading of the more fully-developed disease.

It is necessary, however, to insist very strongly on careful attention being paid to these vague and ill-defined premonitory symptoms during the first year of infantile life: for there can be no doubt but that during this period the rachitic disease is in active progress, and may then be arrested before it arrives at the stage of deformation of the bones. Indeed, some authorities insist that rickets is present at birth, or even during the antenatal existence of the child; but, even so, careful watch on the child's development and the correction of the various catarrhs of the system, may, in a great measure, prevent the onset of malnutrition and rickets.

#### CLASSIFICATION.

It is convenient to make a rough classification of rickets, based on the fact that in some cases one set of symptoms alone is present, or is so marked that it predominates over all other signs or symptoms of the disease:

I. The Catarrhal Type. - These cases suffer from repeated attacks of bronchitis; and then, about the tenth month or later, the deformities may begin to appear.

II. The Gastro-intestinal Type. - Cases of this variety have a tendency to gastritis, enteritis, or constipation, followed by osseous lesions.

III. The Osseous Type. - No early symptoms are here present; the child is always healthy and strong, though late in developing the power of walking. On examination, characteristic deformities of the femora and tibiae are found to be present, and the brunt of the disease appears to have fallen on the osseous system.

IV. Pseudo-paralytic Type. - The child appears to be healthy, but is unable to stand; the muscles are flabby and flaccid; and the joints are loose and flail-like. There are no signs of true paralysis; and the condition is sometimes known as the "acrobatic form" of rickets.

V. Acute Rickets. - A rapid onset of the disease, leading to a condition of marasmus and cachexia, has been described; but, as it is now generally recognised as scurvy, it scarcely deserves a place in the classification of the manifestations of the rachitic dyscrasia.



### CLINICAL INTERPRETATION OF ABNORMALITIES.

In estimating the development of a growing infant, it is advisable to watch carefully three distinct factors, which give definite information that the health and progress of the child is proceeding along normal lines - viz.:

- (1) A steady and regular increase in weight.
- (2) The proportionate measurements of the head, thorax, and abdomen.
- (3) The general nutrition and tonicity of the muscular system.

In rickets, marked deviation from the normal is frequently observed; and in this connection it must be remembered that increase in weight must not, by itself, be taken as a true index of health: for a fat and flabby child, fed on a starchy diet, may apparently be thriving, - if judged solely by the increase in weight, - though the measurements of the body and the flabby condition of the muscles point to the presence of disease.

The normal ratio between head, thorax, and abdomen is disturbed when the infant develops rachitic disease.

Rotch (Pediatrics) gives the following tabulation of measurements:

	Early Weeks.	Six Months.	Twelve Months.
	Inches.	Inches.	Inches.
Head .....	13 $\frac{1}{2}$	17 $\frac{3}{8}$	19
Thorax .....	13	17 $\frac{3}{8}$	19 $\frac{3}{4}$
Abdomen .....	14	18	19

If the figures of the early weeks are disregarded, and only the period when rickets may be contracted is studied, it will be seen that the head, thorax, and abdomen have almost equal measurements in inches; and also that the thorax is gradually gaining on the head and abdomen, until it finally has the greatest circumference. But, on inspecting a rickety child, the observer at once perceives that the head and abdomen are larger than normal, and also greater than the thorax, which is narrow, contracted, and marked by abnormal furrows and distortions.

#### HEAD.

In rickets the large size of the head is often more apparent than real: for it may not measure more than that of a healthy child; but, owing to the narrow and contracted thorax, by comparison it looks out of proportion to the rest of the body.

In marked cases of rickets, Holt has found an increase of one or two inches in circumference, which is due to the increase in thickness of the cranial bones. ~~The~~

The shape of the head is altered, and is characteristic of the disease. The skull is long in the antero-posterior diameter (dolichocephalic), and is square and box-like; the forehead is broad and projecting ("Olympian forehead"), owing to the bulging forward of the thickened frontal bones. In contrast to the square head, the face looks small and narrow; but there has also been some arrest of its bony growth. The vertex of the head is flattened; and there are well-marked bosses (Parrot's bosses) on the occipital and parietal bones.

George Carpenter (Brit. Jour. Childn. Dis., Vol. i, p. 216) regards these nodes as definite evidence of syphilis, and states that the spleen will be found enlarged in 50 per cent. of such cases. According to him, "it is a syphilitic manifestation, prone to arise in rickety subjects"; and he also affirms (Syphilis of Children in Everyday Practice, p. 72) that rickets is not an essential factor in the production of Parrot's nodes.

The sutures are widely open, and the edges of the bones forming their walls are greatly thickened, - so that a furrow is formed along the line of the sagittal and frontal sutures, and another at right angles along the coronal suture. These furrows, together with the protuberant bosses, give the skull the peculiar "hot-cross-bun" appearance, the "natiform skull" of some writers, which is only seen in severe cases of rickets. Some authorities regard the natiform skull as a sign of syphilis.

Parrot regarded all bosses on an infant's skull as syphilitic; but with this statement G. Still (Practitioner, 1904, p. 98) is unable to agree. The latter observer has inquired carefully into the symptoms and histories of many cases, but cannot satisfy himself that these bosses, whether close to the fontanelles or further removed, really indicate any syphilitic affection. Though undoubtedly they occur in syphilitic infants and often are the results of this disease, yet, he is fully assured that bosses occur on the infant's skull, which, though impossible to distinguish clinically from rachitic bosses, result only from rachitic disease. He makes use of the term "clinically, because syphilitic and rachitic bosses differ in their morbid anatomy; and it may be possible that the clinical manifestations represent two varieties of bony overgrowth, - one syphilitic, the other rachitic, - which differ anatomically in their method of formation.

There may be a want of symmetry in the shape of the skull; and there is frequently flattening of the occiput, which is attributed to the yielding of the soft bone as the child presses its head on the pillow. The enlargement of the head is almost entirely due to a thickening of the cranial bones; and there is little or no increase in the cranial cavity. The bones undergo thickening where ossification shows most activity. It has been supposed that the increase in size of the skull was caused by hydrocephalus; but this is not often a complication of rickets, which affection Holt considers the least frequent cause of enlargement of the head.

The rickety head presents marked differences to that of hydrocephalus. In rickets the head is long, square, and sometimes asymmetrical; in hydrocephalus it is bulging, globular in outline, often pyramidal, and the enlargement, as a rule, is symmetrical in every direction. In rickets the actual increase in circumference may be little above normal; but in hydrocephalus there may be an increase of many inches, and the head, as age increases, grows larger and larger. The forehead, in rickets goes up more or less vertically in front and at the sides;

in hydrocephalus it is high and projecting, with prominent bulging at the temporal regions, overhanging at the eyes, and a characteristic prominence at the root of the nose. The top of a rachitic head is flat; that of hydrocephalus is convex and globular, with widely dilated sutures, and tense bulging anterior fontanelle.

Trousseau compared the opening-out of the the cranial bones, as the head enlarges, to the falling-back of the petals of an opening flower.

Holt considers that rickets and hydrocephalus are only infrequently associated, and is doubtful if there is any etiological connection between the two diseases.

With recovery, the thickening of the rachitic head may diminish gradually, and no trace be left behind, though sometimes it persists throughout life. The peculiar shape of Thackeray's head is supposed to have been caused by rickets in early life.

The margins of the bones remain in a membranous condition, and thickening may be felt along the edges of the sutures. On the occipital, and sometimes on the parietals, small patches of thinned bone,  $\frac{1}{4}$  - 1 inch in diameter, may be found - the "craniotabes" of Elsässer. They are the result of a wasting of the inner table of the bone, and are most frequently observed from the second to the sixth month of infant life. They take four or five weeks to develop fully, and, according to Monti, are rarely seen after the end of the sixth month. Pressure on these spots gives a dry crackling sound, not unlike the noise made by parchment.

Many authorities affirm that craniotabes is only present if rickets is associated with congenital syphilis. In discussing the possibility of craniotabes being a manifestation of syphilis, the statistics of Lees and Barlow (Rep. Soc. Dis. Childn., Vol. iii) have previously been referred to, in which they show that congenital syphilis was present in 47 per cent. of their cases with symptoms of craniotabes; and it is now only necessary to recall to mind that these writers concluded that syphilis was by far the largest factor in the causation of craniotabes.

George Carpenter (Syphilis of Children in Everyday Practice, p. 75) gives as his experience that craniotabes is usually found in the parietal bones (60 per cent.), sometimes in the occipital bone (3 per cent.), and least often in the frontal bones and then only if the other bones of the skull were attacked. His impression is that craniotabes is usually a syphilitic manifestation. Some years ago, he collected 238 cases of craniotabes, and noted that it was seen most commonly during the second, third, and fourth months of life, but was infrequent about the ninth month. This tended to show that, during the prerachitic period, craniotabes was most evident, but that, upon the appearance of rickets, it was only found with difficulty.

Cautley (op. cit.), who examined a large number of cases, agreed that most cases were seen between the second and fourth month, but was most frequently observed in babies fed on condensed milk, boiled foods, and not on breast-milk. He believes that boiling rendered the salts less soluble, and thought it reasonable to suppose that



craniotabes was due to deficiency of salts in the food. He did not consider that craniotabes of this type was associated with syphilis, but was due to errors in feeding, which, later on, led to rickets or other disorders of nutrition.

Comby (Twentieth Century Prac. of Med., p. 538) holds very similar views, finding craniotabes present in badly-nourished infants brought up on the bottle, or receiving an insufficient supply of breast-milk (twins); and he directly opposes the opinion of Parrot: for he believes that syphilis has nothing to do with the production of craniotabes.

G. Still (Practitioner, 1904, p. 99) also doubts whether craniotabes should always be regarded as of syphilitic origin - especially if the definition of craniotabes be taken as a small patch of thinning of the calvarium, at some distance from the sutures, and not a diffuse thinning of the edges of the bone adjoining them. He considers it much more a manifestation of rickets than of syphilis; and, if further proof were needed, he refers to the frequent association of craniotabes with laryngismus stridulus, which is a symptom practically always of rickets, and which rapidly disappears under antirachitic treatment.

From a microscopical study of the bodies of 21 infants, Rasumoffsky (Rous. Vrach, Vol. iii, 5) concludes that there are two kinds of craniotabes in children - rachitic and non-rachitic. The non-rachitic is due to atrophy and undeveloped structure of bone, while the rachitic is produced by lack of lime salts, together with pressure of the brain on the delicate bone. The rachitic changes are usually seen after the third month, while atrophic changes may occur even in intra-uterine life. During life, the softening due to rickets can only be detected if the rosary of the thorax is also present. The two forms of craniotabes show marked differences in their microscopic appearances.

E. Spietschka (Jahr. f. Kinderh., lix, F. 3) examined a large number of children, in Epstein's clinic at Prague, and found that the newborn babies often exhibited softening of the occiput (craniotabes), defects of ossification, yielding and gaping sutures, and a disproportion between the size of the head and chest, which, unless the child receives appropriate treatment, may develop into true rickets. He advises the early administration of phosphorus and cod-liver oil, even in the earliest childhood. The frequent and early occurrence of this softening convinces him that rickets may be, and often is, a congenital condition.

From the foregoing observations, it seems evident that craniotabes can be considered a symptom of rachitis, even apart from syphilis, though it is not always possible to regard it as a sign of this disease alone. But, its presence draws attention to the fact that some condition of malnutrition is present, - possibly syphilitic or rachitic, and associated with a defective absorption of lime salts. If the beading of the ribs can be demonstrated, then a diagnosis of rickets will be made more positive.

The anterior fontanelle remains widely patent, and though usually this closes between eighteen months and

two years, in a rickety head it may remain open up to two or three years of age, and, even as late as five years, a slight opening may sometimes be detected. The veins of the head are unusually prominent, and often, even before other symptoms have appeared, the bald patch on the occiput, due to friction of the head on the pillow, is useful as an early diagnostic sign of rickets.

On auscultation over the anterior fontanelle, a systolic bruit is frequently heard. This symptom, first described by John Fisher of Boston (1833), is of frequent occurrence in rickets; but Osler (Prac. of Med., p. 437) has shown that it is also present in healthy children, though it is seldom heard after the fifth year.

The condition of the skin and hair will be referred to in another section.

The face, owing to the increased size of the head, appears smaller than normal, and the child may have a wizened appearance. The development of the maxillary bones is arrested, and they are soft and stunted in growth. The upper maxilla is more spherical than normal, and the malar bones are very prominent. The inferior maxilla is short, softened in front, and there is thickening of the rami.

Fleischmann describes an angular deformity of the lower jaw, in which there is a bending of the body thereof at the situation of the canine teeth.

The body of the jaw is also rotated on its horizontal axis, and it acquires a polygonal form, which may interfere with the evolution of the permanent teeth or cause them to be placed irregularly. The palatine vault is deformed, the nasal fossa narrowed; and, as the tonsils are pushed towards the middle line, there is a tendency to laryngeal and bronchial catarrhs, as well as to adenoid vegetations.

One of the most important signs of the rachitic dyscrasia is the evil effect of the same upon the first dentition. The teeth fail to appear at the normal periods, and often the rachitic infant of a year old has not a single tooth. In addition to their late appearance, there may be "cross-cutting" - i. e., the teeth are not cut in the regular sequence of dentition. Rachitic children, as a rule, cut their teeth with difficulty. The teeth, when cut, are very brittle, deficient in enamel, - which is often striped and pitted, - and prone to decay early down to the alveolar margin, leaving a young child with unhealthy stumps in its mouth, long before they can be replaced by the teeth of the second dentition, and which become a source of frequent infection of the buccal cavity and alimentary canal. Much of the dyspepsia and anaemia of young children may be attributed to infection from the decaying teeth.

Therefore, if a child at ten months of age has no teeth, the presence of rickets should be suspected, other symptoms searched for, and vigorous antirachitic treatment at once commenced, - so as to avert, if possible, the future onset of bony deformities. Occasionally, a child may cut one or two teeth, and then rickets makes its appearance and interferes with the normal progress of the rest of dentition - no more teeth appearing for many months. This arrest of teething should at once

furnish a clue to the presence of rickets, even though the child is of healthy appearance.

### THORAX.

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The thorax of the adult is oval in shape, but, during the period of infancy, it is cylindrical or almost circular, the ribs and cartilages lie more horizontally, the clavicles are elevated, and the neck is short. The upper part of the thorax contains the heart, lungs, and thymus, while, in the lower half, the abdominal contents crowd into the space under the diaphragm, which has a higher dome than in later life. The abdominal enlargement, which is so frequent a feature of infancy, produces a broadening of the base of the thorax, which, if rickets is present, becomes still further exaggerated. The thorax of the ~~adult~~ is a bony case, but in the child it is soft and flexible, and therefore easily affected by atmospheric pressure, or by any obstruction to respiration. The infant's chest is extremely light and pliable, and the ribs and cartilages possess great mobility; it yields readily to lateral pressure, but, unlike the chest of the adult, has no resiliency and little elastic recoil. The lungs are relatively smaller than in the adult, in proportion to the size of the heart, and also because the other viscera require more space. The pulmonary tissue is exceedingly delicate and elastic. It is easily affected by obstructive catarrh or pressure from without, and very little causes a condition of emphysema or collapse. In the early weeks of life the thorax measures slightly less (about half an inch) than the head, but, by the end of the first year, its circumference should be the greater.

In rickets it is quite apparent that the head is larger than the thorax, which is narrow, flattened and deformed, and its stunted condition is still further emphasized by the protuberant abdomen ~~blugging~~ bulging out below it. The chest loses its cylindrical shape, and approximates more closely to the quadripedal type. If a tracing of a rickety chest be taken with a cyrtometer through the sterno-xiphoid articulation, a figure resembling the periphery of a violin is obtained, the broadest portion being posterior, and the narrow rounded portion anterior, while the construction corresponds to the lateral grooves (Keating's Ency.). At the junction of the ribs and cartilages, particularly from the fourth to the ninth ribs, the thickened nodes, which together make up the rachitic rosary, are evident. In a rickety child the ribs are ~~softer~~ softer than the cartilages; in the healthy (and even more so in the tubercular) the cartilages are softer than the ribs (Jenner). Owing to the softness of the bones and cartilages, the chest loses its firmness, and is easily depressed by atmospheric pressure, or sucked inwards during the act of inspiration - a condition which still further is assisted by the ~~great~~ **great** flexibility of the chest wall.

Jenner particularly insists that the deformity of the chest is produced by atmospheric pressure, aided by the position of the upper margin of the liver, stomach, and spleen, and not by the contraction of the diaphragm.



The chest wall covering the heart does not recede so much as that of the opposite side,- so that the left side appears bigger than the right, and thus gives an impression of abnormal fulness in the precordial region.

When the chest wall is sucked in, and there is any obstruction to inspiration, the costal margins will be drawn inwards; and if interference is more pronounced, a groove appears on either side of the chest, running backwards and downwards round the anterior portion of the thorax. It disappears when the obstruction is removed, but permanent deformity may remain, if the ribs are soft and weakened, as will be the case in rachitic disease. In rickets this groove or transverse furrow is known as "Harrison's groove." It consists of a depression, about two inches broad (the rachitic girdle), which lies at the level of the attachment of the diaphragm, encircling either side of the chest from the lower end of the sternum backwards to the posterior margin of the axilla, and becomes more marked if any disease of the lungs causes increased suction inwards of the chest wall. This lateral furrow serves to mark the upper limit of the abdominal viscera, which press out the chest wall below the groove, giving the lower part of the thorax a dome-like shape. The lower costal arches are moulded upon the abdominal contents, and there is thickening and eversion of the lower edges of the ribs and cartilages, which has been compared by some writers to the nape of a hat.

The lateral groove is not solely confined to rickets, but, if bilateral, should give rise to the suspicion that the disease is present. Flattening on one side of the chest wall, as a rule, indicates a neglected pleural effusion.

The Harrison deformity is brought about by three factors,- the lungs, muscles, and the bones of the thorax. The short inspiratory act of the infant is interfered with, and there is not complete expansion of the lungs. The ribs are soft and sunken, and therefore the ~~intercostals~~ <sup>intercostals</sup>, deprived of their fulcrum, are unable to act with any power, and the diaphragm is left to control the act of inspiration, which it can only imperfectly perform as it is not so strong as the atmospheric pressure acting from without. In the later stages, the atony of the abdominal muscles increases the embarrassment, as well as the deepening of the groove.

A second groove, vertical in position, passes down the chest wall, lying outside the nipple line, on each side, alongside or behind the rachitic rosary, at the junction of the ribs and cartilages. This groove descends outwards and obliquely downwards on the anterior wall of the thorax; its position is determined, not by the lack of power of the respiratory muscles attached to the outside of the ribs, but by the softness and the want of resistance of the ribs themselves (Jenner). Occasionally, a slight groove can be felt immediately anterior to the rachitic rosary.

The softening of the ribs and the lateral pressure cause the sternum to bulge forwards, and there may be a vertical groove running down its centre. The projecting

sternum of rickets has a rounded outline, and must be differentiated from the sharp pigeon-breasted chest caused by whooping-cough, bronchitis, or prolonged mischief in the lungs during early life. The pigeon-chest is much more angular, and has a sharp projection resembling the breast of a bird. The pigeon-breast may be associated with the rickety chest, when the deformity is much increased, and also modified in appearance. Less frequently, a deep central hollow over the ensiform cartilage, about one and a half inches in depth, can be observed in a rachitic thorax, and has been named the "funnel chest".

The beading of the ribs is generally noticed some months before the deformity of the chest wall draws attention to the presence of rickets.

As the child grows older, the various furrows in the thorax tend to disappear, and the chest assumes its normal aspect. The rickety chest can frequently be observed up to five or six years of age; but, as the child develops, the visceral organs sink further into the abdomen, and the chest walls expand more freely as the lungs secure greater play.

Theodore Fisher (Brit. Jour. Childn. Dis., p. 6) gives a sketch, from his notebook, of a rickety chest, drawn when the infant was ten months of age. Eight years later, he once more saw the child, then a delicately formed girl with a well-shaped chest, and the flattening of the top and back of the head, present in infancy, had almost disappeared.

#### PELVIS.

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The bones of the infant's pelvis are not easily felt, - so that it is not always possible to detect the changes therein occasioned by rickets. In common with the rest of the skeleton, the bones are soft, and there may be thickening of the ilia about their edges. The pressure of the spine and of the abdominal organs downwards, combined with the upward pressure from the legs, crushes in the softened bones, and the whole pelvis has a distorted and stunted appearance. Later, there is diminution of the antero-posterior diameter at the inlet, and the brain becomes kidney-shaped, with a narrowing of the subpubic arch, and a partial rotation of the sacrum upon itself, - so that the promontory is pushed forwards and the coccyx backwards, with increase of the antero-posterior diameter at the outlet. Irregular deformities - "crumpling of the pelvis" - may be present.

The early detection of rachitic changes in the pelvis is most important: for the disastrous effects upon the women in childbearing need not be dwelt upon at the moment; and every effort should be made to prevent distortion before the bones grow hard and eburnated and the shape becomes permanent.

Chalmers (Physical Deterioration) states that the number of operations for contracted pelvis have increased in recent years in Glasgow, but affecting the women who, a generation ago, required osteotomies as children. The number of osteotomies in children is now decreasing, so there is hope that the obstetrician of the future will see fewer women with the true rickety pelvis.

Owing to the softness of the bones of the pelvis, the use of tight napkins may produce deformities of the same, and the wadding, if firmly padded between the thighs, may wedge out the legs and give rise to curvature of the femora. This disaster may even occur in healthy children; and A. C. Cotton (Arch. Ped., 1903, p. 89) draws attention to the evils of tight clothing in infants, illustrating his article with instructive and convincing skiagraphs. It is therefore of great importance in rickets to avoid any undue pressure from these diapers.

### SPINE.

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The bones of the spine are softer than normal, and their ligaments weak and flabby. The result of their laxity is that the spine gives way and bows backwards. The earliest and commonest change is increase of the great accommodation-curve in which the lumbar spine may be involved (kyphosis). The most frequent deformity is a posterior curve, extending from the mid-dorsal to the sacral region. If the child walks, the curve is limited to the dorsal vertebrae, and there is anterior curvature in the lumbar region. The cervical anterior curve may be increased, causing the face to be directed upwards.

The kyphosis of rickets should not be confused with Pott's disease of the vertebrae: for the curve (of rickets) is more rounded, and there is no sharp angular projection as in tubercular disease. Moreover, if the child is laid on its abdomen and lifted up by its legs, the curvature of the spine, if due to rickets, will straighten out and disappear, but, if true disease of the bones be present, the curve cannot be thus obliterated.

Holt considers that marked lateral curvature, in children under three years of age, is usually due to rickets.

The curvature of the spine of rickets may be mistaken for caries. If the child has shown no previous symptoms of disease, but is late in walking or has weak ligaments and feeble flaccid muscles, it is really a case of the so-called "acrobatic form" of rachitic disease. It is possible, however, for Pott's disease and rachitis to occur simultaneously in a child, and so lead to a confusion in the diagnosis.

Edward Wyncoop (Arch. Ped., 1905) records such a case, in which there were present rachitis, Pott's disease, and spastic paraplegia of the lower extremities.

There is occasionally severe pain in the back in rickets; and the presence of this symptom in a child should lead the observer to suspect spinal caries, rickets, or scurvy.

W. Ewart (Brit. Jour. Childn. Dis., Vol. ii, p. 157) draws attention to the flexibility of spine during early life, and shows that it assists greatly in the respiratory function, and at the same time gives practice to the muscles, which in later life will hold the body erect. In the adult it is a firm bony column, but in the infant it is a flexible rod capable of worm-like writhing or movements, which become very noticeable when hyperpnoea is present. Any deformity of the thorax, as in rickets, or obstruction to the proper performance of



respiration, acts back with evil effect upon the flexible spine of the child.

Deformities of the spine may be associated with adenoid growths in the nasopharynx. J. Jackson Clarke (Rep. Soc. Dis. of Childn., Vol. 11, p. 17) examined some fifty cadavers of children varying in age from two months to eight years. All the cases, except one, showed signs of rickets, together with adenoid growths. In the non-rachitic case alone the adenoids were not present.

#### COXA VARA AND COXA VALGA.

Coxa vara may be dependent upon a rachitic twisting of the neck of the femur. There is a downward bending of the neck of that bone, and an elevation of the trochanter major, which may be encountered in severe cases of rickets, due to the weight of the trunk acting upon the softened bone. Coxa vara may be unilateral, but more often is bilateral. There is an undue mobility of the joint in certain directions; eversion, abduction, and adduction are more extensive than normal, but the movement of inversion is almost impossible. The angle at the hip-joint is only 100°, 80°, or as small as 60°. Coxa vara can only be ascribed to rickets in a very limited number of cases, and is more often a congenital condition.

Michael Cohn (Jahr. f. Kinderh., 1903, lviii) describes a case of coxa vera the result of early rickets: previously it had not been recognised as of rachitic origin.

Congenital coxa vera may be distinguished from the rachitic variety by the history of the onset, without previous disease, by the absence of other rachitic signs, by the abnormally short neck of the femur, and by the vertical course of the epiphyseal line. In rickets the neck of the femur is longer, and the epiphyseal line runs diagonally from above downwards and inwards, at a sharp angle with the neck at its lower border. Frequently a skiagraph will show curvature of the shaft of the femur, which would help to confirm the diagnosis of rickets.

Coxa valga is the opposite condition to coxa vara, and is sometimes found in rickets. In coxa vara and coxa valga there is a change in the angle of incidence formed by the neck and shaft of the femur: the average size of this angle, according to Miculicz, is 125 degrees. In coxa vara the angle is lessened; in coxa valga it is increased.

The symptoms of coxa valga are increased abduction and outward rotation of the leg; the body tilts forwards, and there may be slight lordosis of the spine. In double coxa valga the gait is peculiar, resembling that of spastic spinal paralysis. The patient walks with a rocking movement, swinging the body from side to side; the hips are slightly bent, and the knees are held strongly extended.

#### ----- SKELETON.

Rickets does not spare a single bone in the body: its ravages can be traced in the head, the trunk, or the extremities, and deformities appear in every part of the skeleton. The parts of the osseous framework which suffer most, and the usual order of their frequency, are

the head, ribs, spine, and pelvis. The thickening of the extremities is usually observed before deformities appear in other parts of the body.

Guérin wrote: "It is an incontestable law, that suffers hardly any exception, that rickets proceeds in the deformation of the skeleton from below upwards, and that the deformity of the spine is the last to manifest itself". The order in which the various parts of the skeleton become deformed he gives as follows:

(1) Swelling of the epiphyses of the inferior extremities.

(2) Deviations of the knee.

(3) Curvature of the tibia and the fibula.

(4) Curvature of the femora.

(5) Swelling of the wrist and deviation of the pelvis.

(6) Swelling and deformity of the ribs, scapulae, clavicles, and spine.

This law of Guérin's nowadays cannot be accepted as a true one: for, as a rule, deformities do not appear first in the lower extremities. Indeed, if craniotabes be accepted as a symptom of rickets, the disease shows itself quite early in the cranial bones, and the thickening of the epiphyses of the wrists, and the beading of the ribs, can usually be detected, - especially if the child is able to crawl, - some time before swelling or curvature is noticed in the lower extremities.

Chance (Bodily Deformities, p. 211) kept a record of 600 cases, and observed how many of the parts of the body were affected when the child was first brought for examination.

Table of 600 Cases of Rickets - The Parts First  
Noticed by the Mother to be Affected:

Leg .....	420
Arm .....	202
Spine .....	28
Chest .....	20
Head .....	20

Chance remarks that the mother doubtless overlooked the enlargement of the wrists, which were always in that condition when the child was brought to him for examination and treatment. In 90 cases, two parts of the skeleton were found to be affected at the same time, and, therefore, the total of the numbers is above the 600.

Mothers always invariably fail to detect the first and early signs of rickets in the head, thorax, or the ribs. Prominence of the forehead, slight flattening of the thorax, or a faint beading of the ribs, would pass unnoticed; but, as soon as the child begins to walk, the soft bones bend and the presence of mischief is recognised. Then the mother, fearful that the child will grow up with bowed or bandy legs, brings it, more or less speedily, for medical advice. It may be that this failure to detect the early deformities accounts for the large number of cases that, when first seen, have curvatures of the lower extremities.

Chance also gives a table showing the frequency and the various deformities of the lower extremities as well as those of the upper. The curvatures of the **upper** extremities usually appear before those in the upper limbs are manifest. This only holds good, however,

if the child has tried to walk early or has been sitting much in the pagoda attitude: otherwise, deformities of the upper extremities may be the first to appear. In the 600 cases he gives:

Knock-knee .....	396
Curvatures of tibia and fibula ....	368
Enlargement of the ankles .....	300
Curvature of femora .....	142

Out of these cases 216 were knock-knees and curvatures, and 170 curvatures without any affection of the knees. In the 600 cases the pelvis was affected only in 16 cases.

Rickets frequently attacks two or more parts of the skeleton simultaneously: it may be seen at the same time in the wrist and the tibia, the wrist and the ribs, or, if in three places, in the wrist, tibia, and chest, or the wrist, the knee, and the head. In many cases, if a more minute examination of the skeleton is undertaken, slight evidences of rickety disease will be found in nearly all parts of the body.

### LIMBS.

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The deformities of the limbs become most evident when the child begins to attempt to walk; but, as this act is often delayed by rachitic disease, attention may not be drawn to the curving or distortion of the various parts of the skeleton until the age of two years, or even later. The thoracic deformity may be lessening when the legs begin to bend, because the disease is now on the decline; muscular power has increased, but the bones of the legs are soft, and give way under the weight of the body.

So long as the child is at rest lying down, little curvature can be detected, but, when it adopts the erect posture and the body-weight is put on the limbs, the deformities and distortion of the extremities begin to develop. For a similar reason, the epiphyseal thickening at the ends of the long bones is usually more marked at the wrists in the early stages of rickets, and, at a later date, in the ankles, because the child first attempts to crawl on all fours, and throws the bulk of its weight forward to the greatest extent upon its hands. In these days fractures at the wrist, - e. g., Colles's fracture, - are frequent. When the child stands up and attempts to walk, the thickening of the epiphyses at the ankles becomes more evident. But, in addition to the body-weight, muscular traction acts upon the soft pliable bone, and produces exaggerations of normal curvatures and distortion of the limbs.

### THE LONG BONES.

The principal changes to be observed in the long bones are thickened epiphyses, exaggeration of the normal curves, and the development of the curves caused by pressure, the appearance of tubercles or irregular outgrowths of bone, and, in the late stages of the disease, deficiency in length and a stunting of the growth.

Jenner states that all the bones of the adult, previously affected by rickets, are diminished in length;



but the lower limbs, including the pelvis, are disproportionately diminished in size, and the face is small in proportion to the skull.

The character of the deformity produced in the bones of the extremities is largely governed by the line of pressure, produced by the position or altitude which is usually assumed by the child. The femur bends outwards and forwards in one large curve, the angle of the neck may be reduced, and coxa vara formed. The curvatures may be symmetrical or unequal, and frequently the two thighs together form an imperfect oval. If knock-knee is present, there may be an overgrowth at the inner segment of the lower epiphyseal line.

The tibia and fibula acquire a forward and outward curve, or a forward one, with generally a sharp kink in the lower third. The tibia often presents a characteristic sabre-blade inflection, and may show deformities from subperiosteal fractures. There may be an overgrowth at the inner segment of the upper tibial epiphysis. The curves of the tibia and fibula in the lower third are due to the position adopted by the child, which most often is sitting in bed with the knees flexed and the legs crossed in the tailor-like fashion. More rarely the tibia and fibula present a sharp backward curve.

The development of bow-leg or knock-knee greatly depends upon the age of the patient, and the aptitude or amount of walking for which the child is able. Bow-leg is much more common in young children: for, at an early age, the gait is more a roll or waddle than straight-forward walking. The child frequently throws a sudden strain on the lower third of the leg in the endeavour it makes to balance or prevent itself falling forward, and in this way produces anterior curvature of the bone with the marked kink in this situation; the lateral efforts made to preserve its centre of gravity causes the outward bend of the bone and consequent bow-legs. In older children, then able to stand or walk about, genu valgum is more common, because in the erect posture the weight of the body is transmitted mainly through the outer condyle of the femur, and in rickets there is an arrest of growth at the outer side of the epiphyses of the femur and tibia, which, however, is unchecked on the inner segment. A bony outgrowth or tubercle is present on the inner condyle of the femur.

Wallace Blanchard (Chicago Med. Recorder, Sept. 15, 1905) reports a series of cases of bow-legs and knock-knee, and shows, by means of skiagraphs, that these deformities of the legs are often of a compound nature, and that a knock-knee may be due to a deformity of the femur or tibia alone, or to a deformity of both these bones.

In some cases there might be an outward bowing of the femur and an inward bending of the tibia. If one bone alone is affected, the limb may show deformity, but with curvature of more than one bone, the limb, as a whole, may appear straight. When straightening a crooked limb, it may be necessary to make a further deformity, in order to correct a limb that only has a simple deformity. The X-ray picture should therefore prove of the greatest

value to a surgeon about to correct a case of bow-leg or knock-knee, by showing accurately the nature and number of deformities present.

#### THE UPPER EXTREMITY.

The epiphyses at the elbow and the lower epiphysis of the radius and ulna are markedly enlarged, and are early evidence of the presence of rachitic disease. This epiphyseal thickening is especially evident at the wrists, and forms a bulging or bracelet at the radio-carpal joint. Greenstick fractures are of frequent occurrence in the neighbourhood of this joint. The humerus bends outwards, and its greatest convexity corresponds to the insertion of the deltoid muscles. The radius and ulna also curve outwards, and if the child, unable to walk, has crawled very much on all fours, the curvature will be most marked in the lower third of the bones, owing to the direction of the pressure on the pronated forearm and the spread-out hand.

Koplik (*Dis. of Childn.*; *Arch. Ped.*, 1904, p. 770) describes a condition of the hand which may be mistaken for syphilitic disease of the bones, unless definite symptoms of rachitis are present. It consists of a bowing of the hand with thickening of the phalanges, and the fingers are longer and more tapering than normal. The X-ray shows that the shafts of the phalanges are thickened, and that the peculiar shape of the fingers is due to changes in the bone, and not to any alteration of the softer tissues. The increased length and tapering of the fingers is caused by the laxity of the ligaments of the phalangeal joints. The distance between the extremities of the phalanges which make up the joint is greater in the rachitic than in the normal hand, and may be the cause of the curving inward of the fingers at the joints. Most of the infants seen by Koplik, in whom the rachitic hand could be demonstrated, suffered from marked rachitis, accompanied by such acute pain in the bones that it almost suggested a syphilitic affection; but, clinically, the evidence was opposed to this theory, and strongly proved that the real nature of the disease was rickets. A photograph of the hand is shown in Koplik's "Diseases of Children".

Siegert, at a Congress of German scientists at Cassel in 1903, published a notice and a portrait of this "rachitic hand".

B. Neurath (*Wiem. klin. Woch.*, 1903) describes a new symptom of rickets, and claims that the disease can be diagnosed readily by an examination of the hand, owing to a peculiar deformity of the bones of the fingers. It consists of a peculiar change in their shape, owing to an apparent sinking of the joints, which gives the proximal, middle, and terminal phalanges a spindle-shaped appearance. If the hand is held against the light, the outline strongly resembles a string of pearls. There is hypertrophy of the second phalanx, whilst the other two phalanges are normal, and form a marked contrast. The enlargement is chiefly on the dorsal surface, and the deformity is best seen by looking at the hand in profile. At the level of the enlargement the skin is stretched, and can only with difficulty be thrown into its normal wrinkles.

Neurath also describes a rarer condition, in which the proximal and middle phalanges are conical in shape,

while the terminal phalanx, at the level of the nail and the finger, looks like a ninepin, or occasionally like a drumstick in appearance. Radiographs show that the thickening is due to an infiltration of the periosteum, which occurs at the middle of the shaft of the bone, and not at the ends of the joints, - so that each phalanx is really spindle-shaped. Thickening of the toes is very rare.

The condition is only found in rachitic children, commonest in the first year of life, and in older children is only noticed in very severe cases. It is always associated with enlargement of the epiphyses and the rachitic rosary. It must be carefully distinguished from the affections due to hereditary syphilis. If hereditary syphilis is present, it affects the ungual phalanx, giving it the appearance of a truncated cone, and this should serve to distinguish it from the rachitic deformity. In rickets the whole finger is affected, the shape is fusiform; and it disappears when the disease yields to antirachitic treatment.

Kassowitz and Monti state that these digital conditions are only seen in the most severe cases, and are of very rare occurrence.

The writer is at present endeavouring to take notes of such a case in the Liverpool Children's Hospital.

Jacob Sobel (Med. News, Feb. 13, 1904) gives a report of two cases. He considers the condition of interest on account of the need for differential diagnosis from tubercular and syphilitic dactylitis.

There may be a permanent shortening of the limbs, - so that a rachitic child of three years often measures six or eight inches less than a healthy child of the same age, the shortening of the lower extremities being the cause of this deformity. The bones are blighted and limited in growth, and permanent dwarfism may be the final outcome of the rachitic disease. It is necessary, however, to make a careful distinction between the dwarfism due to rachitic disease and achondroplasia or certinism.

Guérin affirmed that the diminution in length was so constant that, the dimensions of a rachitic bone being known, the dimensions of the other parts of the skeleton could be approximately determined.

The special liability of rachitic children to fractures has already been referred to.

According to Guersant, rickets is present in one-third of all fractures seen at the Parisian Sick Children's Hospital; and probably the number due to that affection is really greater than this: for many cases of fracture due to this disease are never brought to hospital.

Multiple fractures are not uncommon. Union is delayed, and, if the disease is at its height, it may not occur at all, or only imperfectly. It is usually effected slowly, and with the formation of a large mass of callus in the convexity of the bone. The quality of the callus is determined by the period of the bone-formation at the time of fracture.



THE CLAVICLES.

The normal curve of the clavicles may be exaggerated, or there may be twisting or distortion of these bones. The articular ends are often enlarged, most frequently at the sternal extremity. If there has been a greenstick fracture, a thickened node may be felt about the middle third of the bone.

Out of 600 cases, Chance found 120 cases of curvature of the clavicle, only 60 cases of curvature of the radius, and 36 of the humerus.

The reason for this is not far to seek. The clavicle is a bone of considerable importance: its function is to uphold the arm apart from the body, and to act as a fulcrum on which it performs its movements. Later, when the child begins to crawl, the weight of the body is thrown through the clavicles on to the outspread hands. These bones are therefore obliged to withstand considerable pressure, and if, in a softened condition, they are unable to do so. They accordingly yield under the continuous strain, and become bent and twisted more frequently than the other bones of the upper extremity, which are in more favourable circumstances.

THE SCAPULAE.

The scapulae are thickened, especially along their lower edges; if there is much deformity, the free movement of the shoulders is interfered with. The anterior surface of the bone is rounded, and is more concave than normal.

THE RIBS.

The sinking-in of the ribs under atmospheric pressure and the characteristic nodosities have been referred to under the deformities of the thorax.

Usually the ribs, from the second to the eighth, are most affected. These bones fail to attain a proper length, and the angle becomes less obtuse than under ordinary circumstances.

THE STERNUM.

The sternum projects, or may sink in bodily.

RESULTS.

In the final stage of rachitic disease, the bones become eburnated; and they acquire a condition of extreme hardness, massiveness, and strength far greater than is seen in the case of a normal bone. The increased deposition of bone may be so great that the medullary cavity is partially obliterated. Rickets seems to have a predilection for filling up the concavity of the bones with an osseous outgrowth, as if nature were trying to buttress up its weakest parts.

This eburnation and hyperostosis, when once commenced, does not cease for some time after the rachitic disease has subsided, and there has been a renewal and deposition of the earthy salts. This activity may lead to the production of exostosis and bony spicules, often of great size, which are especially seen in the spine of the tibia. Their presence often is the cause of much inconvenience: for they may result eventually in stiffness or ankylosis of the joints in later life. They have even been known to interlock, and thus hamper free movement.

In the worst cases the deformities last for life, but in milder cases improvement takes place from four

to seven years of age.

Ashby (Phys., Deterioration Rep., p. 327) examined the school-children of Manchester, and found that many had rickets.

The disease injuriously affects the whole physique of the child; in bad cases the bones remain stunted, curved, and bent, the joints knock-kneed, and the muscles poorly nourished. During all this time it digests its food badly. In the worst cases the evils produced in these early years never pass off, and leave the child in some way physically unsound.

Dr. Scott, Factory Surgeon of Glasgow, shows that many candidates are rejected for factory work, owing to imperfect constitution, debility, rickets, and tuberculosis. Rickets shows itself as bow-legs or flat-feet; and these condition quite unfit a boy for such employment.

Ashby (loc. cit.) also points out that many men are refused by the Post Office, owing to flat-feet caused by rickets.

#### THE GAIT.

In rickets, if the child is able to walk, its gait is often waddling, like a flat broad-footed bird, and it may frequently stumble. If it is a fat heavy child, with prominent calves and some lordosis of the spine due to muscular weakness, this may suggest the possibility of pseudo-hypertrophic paralysis. In a case of true rickets, the knee-jerks are present, but they are absent in pseudo-hypertrophic paralysis. The difficulty the pseudo-hypertrophic paralytic child has in getting up from the floor, and the peculiar method it adopts to overcome its difficulties (levering itself up by placing its hands on its knees), ought to help further to distinguish between the two diseases.

#### MUSCLES AND LIGAMENTS.

The ligaments are lax, elongated, and wanting in normal tonicity - especially those about the larger joints. This condition largely assists in the production of knock-knee (genu valgum), and a peculiar hyperextension at this joint (genu recurvatum), weak ankles, flat foot, flail-like joints, and deformities about the hip and spine.

Leonard Guthrie (Rep. Soc. Dis. of Childn., Vol. iii, p. 167) describes a condition, which he names "rachitis pseudo-paralytica hypotonia muscularis," seen in a girl of two years who only weighed fifteen pounds. The mother said that the child was as helpless as a newborn babe. The principal signs of rickets were present, and the child was unable to stand or walk. There was undue mobility of the joints; the knees could be hyperextended (genu recurvatum), and the feet and hands were dorsiflexed to an excessive degree. The muscles were small and flabby. The case could be classed under the acrobatic form of rickets. The disease having fallen almost entirely on the muscles and ligaments, it was possibly also further influenced (as suggested by Edmund Cautley) by mal-development, as well as disease.

The muscles are poorly developed, and are often small and flabby in texture under the microscope; their tissue may appear pale and the striae colourless, blurred, and difficult of definition. The rachitic child cannot hold its head up at the normal period (about the thirteenth week if the back is supported), it is late in trying to sit up (fifth to sixth month), and it is seldom able to walk at the proper age. Instead of walking between the twelfth and eighteenth month, the child may be unable to do so until it is two and a half or three years of age; and this backwardness, together with the presence of weak ankles or deformities of the legs, may first suggest the presence of rachitic disease. The weight of the body, acting on the weak ligaments of the ankles, often causes the feet to splay downwards and outwards; this deformity can be frequently observed in fat and heavy rachitic children, and, as a rule, knock-knee and flat-foot are also present.

Rotch (Pediatrics) considers that the existence of flat-foot, in children over two years old, should lead to an examination for knock-knee - the existence of these two conditions together being dependent in most cases upon present or previously existing rickets.

It may happen that a child may be brought by its parents because they fear paralysis, the history being that for a time the little patient was able to walk or run about, but gradually ceased to do so, became lethargic, preferred to sit still, and crying if roughly handled. The diagnosis might rest between infantile or diphtheritic paralysis and rickets. The flabby condition of the muscles, the normal electrical reactions, the ability to move the limbs and also to walk, though disinclined for exertion, should be sufficient evidence of the presence of rachitis, possibly complicated with scurvy. There may also be history of prolonged lactation by the mother, or of bad artificial feeding of the child, or defective hygienic conditions of life. The condition has been described as rachitic pseudo-paralysis, set up by the weakness of the muscles and ligaments, as well as the softness of the bones. The weight of the body proves too heavy for the flabby extremities, which fail to support it, and the child is rendered unable or disinclined for exertion, though it still possesses the power of movement. The weakness of the muscles of the back to a large extent accounts for the curvatures of the spine, and the inability of the child to hold up its head until long after the normal period of infancy.

But, though the debility and flabbiness of the muscular system is strongly evident in the deformities of the extremities, its ill-effects are also very pronounced on the abdomen; and this is apparent externally in the muscles of the abdominal wall, as well as internally in its contents. In common with the other muscles of the body, the recti abdominis are weak, flabby, and ill-fitted for their work; and, at the same time, they are still further strained and rendered incompetent by the pressure of the protuberant stomach and intestines. They often become unduly stretched, with the result that umbilical hernia occurs, or there is a diastasis of the muscles in the middle line.



Albert Francine (Arch. Ped., Vol. xxi, p. 116) draws particular attention to the occurrence of this condition in rachitic children. Out of ten cases of rickets, whose ages varied between six months and nine years, this condition of muscular atrophy was present in seven.

The condition in question may easily pass unnoticed in infants, but may be more readily detected if the child is raised by the head and shoulders, - so that the recti muscles are put on the stretch. In older children there may even be a diastasis of a half to one inch in width. Muscular atrophy is an early symptom of rickets, and this diastasis may therefore be found as early as the fifth month of life, and long before the presence of deformities draws attention to the presence of rickets. In cases which have shown rachitic symptoms at birth, this diastasis has been detected; but it is doubtful if the condition is in any way hereditary. Though one of the earliest symptoms of rickets, it is slow to disappear, and may persist for years, as the muscles are very slow in recovering a normal tonicity; and this weakness of the abdominal muscles may partially be the cause of visceral ptoses in adult life. The diastasis is produced primarily by the arrest of development and nutrition of the muscles, and secondarily by the pressure of the stomach and intestines, inflated with gas, acting on the weak and flabby muscles of the abdominal wall. This diastasis recti may occur in healthy children, and disappears about puberty. In the normal child, closure takes place from below upwards, and, as a rule, the diastasis is only seen above the umbilicus; but, in the rickety infant, the diastasis involves the whole extent of the abdominal wall.

It is not, however, a diagnostic sign of rickets alone: for Budinger finds the condition present in 75 per cent. of healthy children.

W. Ewart also shows how the loss of proportion between the enlarged abdomen and the narrowed base of the chest causes the diaphragm to work at a disadvantage, and, as it lacks power to project the abdomen in the normal way, the mechanical effect of the shortening of its fibres is a direct pull on its attachments; and this may partially account for the inspiratory recession in the lower costal region. The abdominal distension is also responsible for the dome-like or bulging shape of the lower part of the thorax.

With the abdomen, there is a general atonic condition of the muscular coats of the intestines set up by the rachitis, leading to deficient peristaltic action of the fibres, which causes constipation, flatulence, fermentation of the retained food in the stomach and intestines, and distension of the abdomen ("frog-belly"). Constipation is an early symptom of rachitis, and may be present in breast-fed infants. It is partly due to the weakness of the muscular layer of the intestines, but is aggravated by the laxity and feebleness of the abdominal walls. It may even begin during the second and third months of life, and is to be differentiated from congenital constipation, which always is present from birth.

Dilatation of the stomach, according to Comby, is of frequent occurrence in rachitis, and is probably caused by the weak condition of its muscular coats, aggravated by the stasis and fermentation of the food which helps to further distend the viscus.

### NERVOUS SYSTEM.

The nervous system suffers severely in rachitis: for in the young infant it is a peculiarly unstable part of the organism during the process of development of the latter. It is weakened by malnutrition, and its tissues are injuriously affected, probably by toxins circulating in the blood, and by reflex irritation from other parts of the body, more especially the gastrointestinal tract. The result is that frequent nerve symptoms or explosions are present during the course of the disease, the milder forms being represented by facial irritability, head-nodding, nocturnal restlessness, and sweating - the graver conditions appearing in the form of tetany, laryngismus, and convulsive seizures.

Angel Money has described rickets as "the neurosis-maker par excellence - the greatest creator of infantile disease". It may be possible that the nerve tissue is deprived of ~~the~~ necessary healthy fatty matter, ~~this~~ same retarding the proper development of the neurons.

Though hydrocephalus is rarely associated with rickets, it sometimes happens that the two diseases are found together. The dilated arteries, the low arterial tension, the sluggishness of the arterial circulation, the intense hyperaemia of the cranial bones and of the meninges of the brain, the stasis of the blood at the periphery, - causing diminished removal of the cerebro-spinal fluid, - combine to make a condition in the body favourable to the production of this disease. Tumours and posterior basic meningitis are the most common causes of hydrocephalus, and syphilis as a cause is often mistaken for rickets.

The inability or unwillingness to move the limbs, and the tenderness of the body when handled, may even lead to a suspicion of the presence of infantile paralysis, though closer investigation should show that there is no real loss of power in the limbs, and that the knee-jerks and the electrical reactions are normal.

Starr (Organic Nervous Disease, p. 216), referring to the possibility of confusion of the two conditions, states that rachitis may lead to a sudden febrile onset, with much pain and tenderness in the limbs, and unwillingness to move. "The child", he says, "is not really paralysed, and the tenderness of its bones, the appearance of its gums (Starr evidently refers to scurvy or scurvy-rickets), and the sweating, as well as the lack of limitation of the pain and immobility to one or two limbs, should prevent this disease being mistaken for infantile paralysis".

The real nature of the nervous disorder in a child is apt to be overlooked, and, unless it is realised that the fons et origo of the trouble is rachitis, as evidenced by tetany or convulsions or laryngismus, no treatment will result in a permanent cure. It is therefore of the

greatest importance, when nerve disorders appear in the first few years of life, to make certain that no rachitic element is present, as the actual or predisposing cause of the disease; and, if found, treatment specially directed to the cure of rickets must be instituted.

Rickets may leave a lasting impression in the nervous system, - especially of the child is the offspring of neurotic parents. Though the rachitic disease has disappeared, the child may grow up unduly excitable and emotional, possibly with only slight nervous symptoms, - such as twitching of the muscles of the hands and face, and constant restlessness. Disordered digestion, excessive schooling, overstudy, and excitement easily produce irritability, sleeplessness, and night-terrors leading to more serious disorders. The convulsive troubles of rickets may even be the precursors of true epilepsy. Unless due care is exercised, the rachitic child may have its nervous system left so unstable and irritable that, in later life, it easily falls a prey to neurasthenia and hysterical affections.

### CONVULSIONS.

Any reflex irritation - especially such as induced through the disorders of the alimentary canal and acting on the unstable nervous system of a rickety child - is liable to set up convulsions. Infants suffering from rickets are more prone to convulsions than healthy children of a similar age, and an attack may be the actual cause of death. Many cases of convulsions ascribed to teething may be really of rachitic origin: for in this disease dentition is delayed and rendered more difficult, owing to the frequent presence of gastro-intestinal disturbances. In a healthy child teething is a ~~normal~~ physiological process, and there is little disturbance of the nervous system, but in rickety children the cutting of a tooth may be as the match that lights the fire, and give rise to a nervous explosion. A normal dentition never produces a convulsion, and "difficult dentition as a cause of convulsion is among the affections which are as rare as they are too readily diagnosticated" (Jacobi).

James Taylor (Nervous Diseases in Childhood and Early Life, p. 295) has no doubt that a large proportion of the cases of convulsions which occur in early life, later than its commencement, are associated with the condition of rickets, and suggests that, in cases of rickets with convulsions, there may be some want of co-ordination between the development of the nerve tissue proper and the fibrous tissue which acts as its scaffolding, this leading to instability of the cells and their consequent discharge. He further points out that the higher nerve centres normally control the lower centres, which, if ungoverned, have a more or less automatic action of their own. Any interference with the development of the higher nerve centres leads to (1) instability of the lower centres, with a tendency to discharge and consequent convulsions, or (2) the development of the higher centres may be insufficient to enable them to control the lower centres, - so that these again automatically discharge and cause convulsive attacks. He therefore classifies the attacks as higher-level and



lower-level fits, easily induced by any peripheral form of irritation, and states that it must be borne in mind that there is a close relationship between rachitic convulsions and epilepsy, and the infantile attacks may be the determining cause of the epilepsy which supervenes in later life.

Thomas Divine (Brit. Jour. Childn. Dis., Vol. iii, p. 448) gives the death-returns ascribed to convulsions, various rickety conditions, teething, laryngismus, and scurvy:

Cause of death .....	Percentage of Deaths, 1903.		
	Months. 0-3	Months. 3-6	Months. 6-12
Convulsions .....	62.0	20.9	17.1
Rickets group .....	3.7	17.2	79.1

For the first three months of life rickets does not enter into the calculations, and during this period the principal cause of convulsions is hereditary influences (Ashby and Wright, - Lancet, 1905, p. 135); and to this Divine would add the use of improper foods. Between three and six months of age rickets is in the incipient stage; but, during the last six months of the first year, it is easy to detect its influence, - so that, between the ages of six months and three years, Ashby finds that the large majority of children who suffer from convulsions show signs of rachitic disease. In 1903, there were 2255 deaths of children between six and twelve months of age registered as due to convulsions, but of these only 444 deaths were ascribed solely to rickets. Divine considers the mortality due to rickets as being understated. The rachitic mortality is probably increased to 2283, if teething and laryngismus are added; but, even then, deaths caused by bronchitis and diarrhoea of rachitic origin are not included. It is impossible to arrive at the true infantile mortality due to rickets, unless the true rachitic origin of the final disease causing death is appreciated and noted on the certificate of death.

John Thomson (Practitioner, 1905, p. 570) regards rickets as the most important of the predisposing causes of convulsions, and the only one that is amenable to immediate treatment. The tendency to convulsions in rickety children disappears, if they are put on anti-rachitic treatment, even though the peripheral cause of irritation remains, because the abnormal sensitiveness of the child to influence of the same ceases, and it is even unnecessary to administer any sedatives. He finds ~~that~~ rickets is usually in any early stage between six months and two years, and most commonly observed in the spring when the cold winds are blowing. The diagnosis rests on the presence of rachitic disease, a history of previous facial irritability (Chvostek's symptom), laryngismus, provided fevers and cerebral disease have been excluded.

On the other hand, though admitting that the association of convulsions with rickets is very common, Cautley (Clin. Jour., Vol. xvi) asserts that too much importance has been attached to the connection: for rickets, by its bony changes or even its craniotabes, cannot explain the convulsive phenomena. He considers

that the true explanation is to be found in the presence of dietetic errors, which have given rise to rachitic disease: for only comparatively few rachitic infants have convulsions, whereas rickets itself is a widespread affection.

It is therefore only justifiable to regard rickets as a predisposing cause, mainly on account of its complications, bad diet, gastro-enteric disturbances, bronchitis, teething, and partly from impaired nutrition with consequent diminished control of the nervous system.

Holt (loc.cit., p.697) regards rickets as the most important predisposing cause for the disturbance of the nutrition of the brain. The instability of infancy is most frequently engendered by rickets, and, if convulsions occur without evident cause, search should always be made for the presence of this disease. Convulsions may occur in children with enlargement of the ~~thymus~~ gland - a condition often associated with rickets, which disease is possibly the original cause of the nervous disorder.

The convulsions of rachitic children usually affect the entire body, and very seldom are unilateral in distribution. As a rule, they are not dangerous to life, but they tend to weaken the nervous system, and may be the starting-point of true epilepsy in later life, - so that a convulsion must not be lightly disregarded, and every effort should be made to prevent any recurrence thereof. If the presence of toxins is suspected, the digestive system should receive attention, and anti-rachitic treatment adopted, and all possible means employed to build up a sound nervous system in a healthy body

#### HEAD-ROLLING.

This symptom may be present in rickets, generally in the early stages of the disease. The child rolls its head monotonously from side to side; and frequently in these cases there can be seen, on the occiput, the characteristic thinning of the hair. The rolling may continue during light sleep, but always ceases when the child sits up. As a rule, it occurs in infants under two years of age, and its presence is often associated with rickets.

Geo. Still found rickets in 15 out of 19 cases examined; and in 4 cases other nervous disorders dependent upon rickets - laryngismus with facial irritability in three, and facial irritability alone in one - were present. The disease is almost entirely one of infantile life, most frequently between six and twelve months, and seldom seen after the end of the second year. If ~~is~~ very pronounced or persistent, the disease may even suggest the possibility of meningitis being present. Still (*Clinical Jour.*, Vol.xxix, p.88) doubts if rickets ought to be considered as an essential factor. In one of his cases, head-rolling began at four weeks; and in some cases he noted specially that rickets was absent, - so that some other factor was present as the cause, probably some form of peripheral irritation. He found that the most constant form of peripheral irritation present was middle-ear disease, and head-rolling appeared long before it was possible to detect any aural symptoms or suppuration. Latent middle-ear catarrh was found present

in 15 out of 29 cases. The other usual cause generally present was the irritation of dentition.

It is of interest to note that among the minor symptoms of rickets Burnet (Med. Press, 1905, p. 54) includes head-rolling and otorrhoea, and says that the latter condition is very commonly present in this disease.

#### HEAD-NODDING - SPASMUS NUTANS.

In this condition there is rhythmic movement of the head - a nodding backwards and forwards, or from side to side like a toy animal. The motion of the head is most frequently in the antero-posterior direction of the body, though it may be combined with a lateral rotation. Head-nodding may be associated with nystagmus, which, as a rule, is more marked in one eye than in the other, and sometimes is limited to a single eye. The direction of the nystagmus may be vertical, horizontal, or rotatory.

Geo. Still, in 20 out of 25 cases of head-nodding, found rickets present.

Haddon (Allbutt's Syst. of Med., Vol. vii, p. 904), in a first series of cases (Lancet, 1890), had only two showing signs of rickets; but, in a second series, nine out of twenty cases showed symptoms of this disease.

The affection usually appears between the sixth and the twelfth month of infancy, and is seldom seen after the second year. It is more frequent in the winter months, and rarely begins in the summer season.

In 80 per cent. of G. Still's cases, it began during the five months of November to March; and, if Dr. Thomson's cases are added also, the percentage is 86.

The fact that the time of onset is confined to the winter months serves to distinguish head-rolling from all other forms of infantile gyrospasm, which commence with equal frequency at any time of the year. Owing to its appearance always during the winter months, it was assumed that head-rolling was set up by darkness, and a comparison sought for between it and the nystagmus of miners. From this view Geo. Still strongly dissents, and compares (Clin. Jour., Vol. xxix, p. 91; Lancet, July 18, 1906) the seasonal incidence of spasmus nutans with that of laryngismus stridulus, which is also seen most often between November and March.

There is a very close connection between laryngismus and rickets; and many writers assert that this disease is most frequently observed during the winter months, - so that this affords strong grounds for believing that many cases of spasmus nutans are due originally to the rachitic element present.

Henoeh attached special importance to dentition as a cause; but Haddon (Allbutt's Syst. of Med., Vol. vii, p. 904) appears to have met cases, in which dentition neither caused or aggravated the movements; and, in the majority of his cases, the usual signs - local or general, and pointing to disturbances of dentition - were absent.

Peterson's observations do not, however, support Henoeh's view, though teething may cause relapses of the condition.



Jacobi (loc.cit.,p.355) attributes the disease to a central cause (rachitis), or to a reflex influence (disorder of the intestines), and points out that the patients are often thoroughly anaemic.

Henry Ashby regards the head-shaking and head-nodding as coördinated neuroses associated with purposive or instinctive movements, which become confirmed into a habit.

The head-shaking movements (Wightman Lecture, - Rep.Soc.Dis.Childn., Vol.v, p.256) may first be noticed, at the third or fourth month, when the infant first attempts to lift up its head or to look about. It is generally seen in infants and children of low vitality, many of them rickety in greater or less degree; but Ashby has not seen these movements in any cases of severe rickets.

The writer has only seen one case in private practice. The patient, a little girl and a visitor to Hoylake, had had whooping-cough, and, when seen, was suffering from pneumonia and collapse of the left lung. There was nystagmus, - more especially of the left eye, - associated with head-nodding; but the latter symptom was only slight in degree. There was no definite evidence of rickets; but the child, as an infant, had been artificially fed.

#### HEAD-BANGING.

This condition usually occurs between six months and two years of age, and is seldom seen after the child has passed the fifth year. The most characteristic sign is a constant beating of the head by the child with its fists, or banging the head against the cot or on the floor. Rickets is found present in a certain proportion of the cases, though it is not certain that this disease is the real cause of this nervous phenomenon. It is probably also associated with dentition, and other reflex irritations.

Osler (Allbutt's Syst. of Med., Vol.vii, p.884) considers that it should be classified, together with the head-nodding, as a coördinated tic.

Geo. Still (Clin. Jour., Vol.xxix, p.89) finds rickets present in some cases, but ascribes the cause as most frequently an irritation due to middle-ear catarrh or dentition.

George Carpenter showed, at the Society for Diseases in Children (May 4, 1905), the brain of a child, aged sixteen months, the subject of head-banging. In brief, the history was that the patient, at five weeks of age, had screaming fits, began to bang his head about, and seemed unable to see. At four and a half months there was a rash, as well as a discharge from the nose. The child was anaemic, had snuffles, and was possessed of four teeth. The ribs were beaded, there was slight enlargement of the epiphyses, and the anterior fontanelle was not closed. The patient died from broncho-pneumonia. The appearance of the brain resembled that of a general paralytic. A clear and oedematous-looking fluid lay between the layers of the pia-arachnoid; the arachnoid itself was more opaque than normal, and had thickened patches scattered through it. The chief feature in the brain was

the increase in the number of medium-sized blood-vessels in this membrane. The ventricles were not dilated. The brain was normal in size, but the convulsions over the frontal region were smaller than normal.

#### BODY-ROCKING.

This is a curious swaying to-and-fro movement of the trunk whilst the child is sitting, as if it were crooning a lullaby. Body-rocking occurs almost exclusively in the sitting posture, and is not therefore seen in infants under nine months of age. There may be a combination of movements, rhythmic in character, which occasionally even continue during light sleep. Body-rocking has been observed in cases of rickets: for these children are inclined to sit quietly, as they are lethargic and disinclined for exertion. Some rickety children have a habit, when sitting up, of swaying the body backwards and forwards, using the hips as a pivot (Carmichael, - loc. cit., p. 175). They often adopt the pagoda attitude, which resembles the well-known position of Buddha: for they are seated on the floor with their legs crossed in front or under the body, and with folded hands. If the child assumes this position, body-rocking is often indulged in.

#### TETANY OR CARPOPEDAL SPASM.

This is a nervous disorder, more particularly of infant life; and it has for its special feature a spasmodic contraction of the flexor muscles of the forearm and the back of the leg. The contractions are usually bilateral, and, if limited to the muscles of the hands and feet, the disorder is defined as carpopedal spasm. Rachitic is also frequently present; and tetany and laryngismus are often associated together.

Holt considers that tetany and laryngismus are very rare, except in rachitic patients; and Jacobi believes that the majority of cases are connected with this disease, - especially when there are marked cranial symptoms, such as craniotabes, - or with laryngismus. It is endemic, and even epidemic during a cold spring season.

Burnet (Med. Press, 1905, p. 54) states that tetany, not due to gastric disturbances, is always set up by rickets.

During an attack, there is spasm of the interossei, and the wrist is flexed at an acute angle; the phalanges are extended, though the terminal phalanges are usually flexed and drawn towards the palm of the hand. The principal flexion is at the metacarpo-phalangeal joint. The thumbs are powerfully adducted, and tucked into the palm - almost across the hand to the little finger. The hand assumes a cramped shape, and has therefore been compared to the obstetrical hand, which name it bears. The feet are extended (equino varus), and the toes forcibly flexed and drawn into the soles. If the spasm affects the trunk, the dorsal muscles are seldom affected, but the muscles of the ventral aspect are contracted. Spasm of the sphincter vesicae may cause retention of urine. The reflexes appear to be normal. There is an excessive excitability to both galvanic and faradic currents, and the electrical irritability is characterised

by the fact that the opening contractions (especially the anodal opening contractions) are in excess of the closing contractions of the galvanic circuit. Vaso-motor phenomena may be noted: oedema of the hands and feet, a skin which is pink, shining, and painful to the touch, and often redness and coldness of the extremities. If the condition is due to rickets, the spasm is usually limited to the hands and feet, though the muscles of other parts of the body may be implicated. There may be an abnormal irritability of the facial muscles. If the masseter muscle of the face is lightly tapped, there is obtained a contraction of the muscles of the forehead on the same side; or light percussion of a nerve trunk may cause contraction of the muscles it supplies (Chvostek's symptom). Spasm, excited by pressure upon the large nerve trunks and arteries of the part affected, is known as Trousseau's symptom. As a rule, concurrent disorder of the digestive tract requires treatment before the disease can be cured; and tetany is therefore to be regarded only as a complication of other conditions, and not as in itself a fatal disease.

#### LARYNGISMUS STRIDULUS.

This is a nervous disease, peculiar to infancy, in which there is an incoördination of the muscles of the larynx and spasmodic closure of the glottis, and rendering the child for the time incapable of breathing. It seems an almost universal opinion that this disease seldom or never occurs unless rickets is present.

Jacobi (Therapeutics of Infancy, p. 143) considers that it is almost always connected with rickets, and is caused by its menigeal and encephalic effects.

Eustace Smith does not believe that laryngismus is due to central irritation, but regards it as a reflex condition depending upon peripheral irritation, which acts on an irritable nervous system, which as is usually present in rickets.

Gee observed 500 cases, and, in all but 2, found rickets present. It invariably occurs between the sixth and eighteenth months of life, and males appear to be more liable to be affected than females.

In a delicate or rachitic infant, a spasm may be excited by any slight irritant: a breath of cold air, fright, passion, a tickling of the throat, excitement or emotional disturbances are all capable of producing an attack of this distressing accident.

The "kinks" observed in some children should be classed as mild forms of laryngismus. The child suddenly holds its breath for a few seconds (paralytic apnoea) while at play, or if suddenly excited; it throws its head back, and, if the attack is slightly prolonged, becomes blue in the face; the conclusion of the attack is usually marked by a loud crowing inspiration, through the spastically-contracted glottis. In the more severe attacks, the period of apnoea may be dangerously prolonged. The attacks occur most frequently at night, or in the early hours of the morning. Laryngismus may also occur at long intervals, but, if the attacks are neglected and no treatment directed to their real cause, they become more frequent, and a child may have several



paroxysms in one day. It is necessary to distinguish laryngismus from congenital laryngeal stridor, and the spasms of whooping-cough.

The presence of this disease should never be regarded lightly; and the gravity of the condition is very considerably increased if complicated by tetany or convulsions - for then an attack may prove fatal. Pulmonary collapse - so often present during the course of rachitis - is increased by laryngismus, and also may be another dangerous factor of the paroxysms are frequent or prolonged.

The duration of the disease, though indefinite, is very amenable to prompt treatment - especially if directed towards the improvement of the true cause of the disorder, that is, rickets. Laryngismus may only therefore last a few days, or appear at varying intervals of time, for several months; but, if anti-rachitic remedies are given, there may ensue a rapid and complete recovery.

In c o n c l u s i o n, though many of these **minor** nervous symptoms are not confined solely to rachitic disease, yet, in a child under two years of age, its presence should be sought for, and, if found, the line of treatment should be towards curing the constitutional disease: for it is probably the actual cause of the neurotic conditions.

#### THE MENTAL CONDITION IN RICKETS.

The brain often suffers from a condition of hyperaemia, which, in time, may produce serous effusion and hydrocephalus; at other times, the brain is markedly anaemic, or there may be a true hypertrophy of the cerebral tissue.

Sir. William Jenner describes the brain in rickets as suffering from albuminoid infiltration in common with the liver, spleen, thymus, and lymphatic glands.

Trousseau described rickety children as possessing precocity and intelligence beyond their years; and he suggested that this was due to the fact that the softness of the cranium favoured more easy development of the nervous centres, which resulted in the intelligence being in advance of the age of the child.

Ritter v. Rittershain, however, has, by measurements, shown that, as a rule, the skull is no larger ~~in~~ rickety children than in healthy children of the same age.

It is possible that rickety children, being quiet and indisposed to play games with companions of their own age, mix more with grown-up people, and consequently are liable to become old-fashioned, though they are really dull-witted and by no means intelligent. The tendency of the disease more often is to induce a condition of lethargy: for the brain and blood suffer deterioration from the malnutrition which affects all the tissues of the body. The rickety child prefers to sit quietly by itself, often with its legs crossed tailor-wise, in the position sometimes referred to as the "pagoda attitude", which strongly contrasts with the normal activity of a healthy child that is seldom still but crawling or running in every direction.

R. Clement Lucas, in the Wightman Lecture for 1904 (Brit. Jour. Dis. Childn., Vol. i, p. 341), states that it

seems certain that rickety children are often cleverer than other children, though he admits that this fact is difficult of explanation. (This, however, is not reported quite accurately: for the Wightman Lecture - reported in the fourth volume and three hundred and forty-second page of the above-mentioned publication - credits him with the following statement: "I think it may be said that persons recovered from rickets and who have afterwards been well nourished often show greater capacity for learning".) But, evidently influenced by this view, he suggested (in 1881) that cases of microcephaly should be so treated as to develop rickets, in order to enlarge the head and allow the brain more room for its development. But this writer, in the same lecture, regards rickets and syphilis as the two great causes of physical deterioration in London.

It may be that cases of rickets have been confused with those of achondroplasia. These children, as a rule, possess an unusual degree of mental vigour. They are quick-witted, bright, and, as a rule, possess an unusual degree of mental vigour; they are also more intelligent than children of their own age (Jenner). Taylor, however, says that they are dull-witted, and possessed of a lowered intelligence and weakmindedness.

A symptom ~~in~~ rickets, pointing to lethargy or impairment of the mental faculties, is the backwardness of the child in learning to talk. If, during the second year, a child makes no effort to talk, rickets or some mental deficiency should be suspected. The child should attempt to talk about the sixteenth month, and ~~make~~ more rapid progress during the third year.

Warner (The Study of Children, p. 233) does not find any evidence of precocity in the rickety child; he writes that these children are delicate, that they grow up stunted, and that about one-third of them prove to be dull pupils.

It seems more probable that the mental condition is lowered by so profound a disturbance of nutrition as is produced by rickets, and any precocity in these children cannot be regarded as real or lasting. The fact that backward children have suffered in earlier life from rickets has been proved by several observers.

G. E. Shuttleworth (Brit. Med. Jour., Oct. 3, 1902) finds, among the poorer classes, frequent examples of mental hebetude and backwardness, due to malnutrition, injuriously affecting the brain. A rachitic form of feeble-mindedness has been described; and it is possible that the bossed and thickened skull interferes with the growth and development of the brain, though probably the general malnutrition of rickets, which acts directly on the actual brain substance, is a more powerful factor in the production of the mental backwardness observed in these cases. He remarks that, even in children of the well-to-do, rickets may result in abnormal mental development.

The mental condition of rachitic children has been studied by Eichorst, Bourneville, and others, who have shown that, in combination with liveliness of spirits and some precocity, they undoubtedly exhibit mental

deficiency.

Out of 435 feeble-minded children, Bourneville and Lemaire (Arch.d.Neurol.,1903) found, in 34, unmistakeable signs of rickets present. In rickety children the defects were not congenital, but were first evident from the eighteenth to the twenty-fourth month, and frequently the initial cause was an attack of gastro-enteritis or broncho-pneumonia. In a few cases so complicated, deformity of bones alone resulted, instead of mental enfeeblement, suggesting that the same toxic or infectious agent was at work, but producing different results. No stigmata of degeneration were found in the rachitic children, - so that the mental defect was not produced during foetal life.

Paul Renoult, of Paris (These de Paris, 1903), gives a full account of the mental and cerebral conditions in rachitic infants. He points out that the large brachycephalic skull, with protuberant Olympian forehead, differs from the degenerate skull, which is often asymmetrical in shape and of oblique formation. He concludes that ~~we~~ are not entitled to say that rickets is the cause of weakmindedness, but that both rickets and weakmindedness are sometimes due to the same infective processes and toxæmias of infancy.

#### RESPIRATORY SYSTEM.

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The lungs of an infant are relatively small, and the air-passages narrow; and the diaphragm, curved like a dome, ascends higher than in the adult into the thorax. The thorax yields readily to lateral pressure, as it has little power of recoil, - so that, owing to the smallness of the lungs and the delicacy of the bronchi and vesicular tissue, which are readily stretched or callapses, - any obstruction readily produces emphysema or atelectasis. The spinal cord and abdominal muscles are also accessory to the act of respiration.

This delicate mechanism, dependent upon the due assistance of the various parts of the body, is readily thrown out of gear, and respiration, like all the other functions of the body, must perforce work at a disadvantage in the case of a rickety child. The narrow and compressed chest, the soft and inelastic ribs, the protuberant abdomen pushing up against the diaphragm, the enlarged liver, and the stomach and intestines often distended with gas, interfere, in the case of the rachitic infant, with the normal act of respiration, which is still further hampered by the atonic condition of the abdominal muscles. The act of inspiration may also be interfered with by the spasm of laryngismus, or, by any catarrhal condition of the bronchial or alveolar tissue, causing obstruction to the free ingress of air, - so that the chest wall is drawn inwards laterally to a still greater degree, and the due expansion of the lungs prevented. The diaphragm shares in the flabby condition common to all the muscles, and the crowding-up of the abdominal contents serves to hamper its freedom of action. It never completely loses its fulcrum, however, because the encroachment of the enlarged abdominal viscera into the



base of the thorax keeps the lower costal arches supported, as well as widely expanded (W. Ewart, - Brit. Jour. Childn. Dis., Vol. ii, p. 251). The spine is lax, and therefore cannot render assistance; and the mechanism of the intercostals is almost paralysed by the softening of the thorax, as well as by the want of support usually afforded by the ribs and normal interosseous spaces.

The loss of abdominal power, together with the weakness of the dorsal muscles, causes the child to be unable to adopt an erect posture, and the force of elastic recoil is diminished; the diaphragm not having any rigid fulcrum (as in adult abdominal atony), cannot force down the contents of the abdomen, and the expiratory elastic recoil is diminished to an equal degree (W. Ewart, - loc. cit., Oct. 13, 1906, p. 921). It is therefore evident that the act of respiration in the rickety child is performed under most disadvantageous conditions; and there must be added also the great tendency for catarrhal affections of the mucous membrane of the bronchial passages and lungs, which are readily excited during the course of the disease, and constitute a special danger to life. The rickety child is always "catching cold"; its mucous membranes are in a sensitive, irritable, and unhealthy condition, and are readily infected by various micro-organisms.

Jacobi (loc. cit., p. 144) alludes to the fact that, though the heart is of average size, the arteries are abnormally large, and there is a lowering of the blood-pressure. This produces a slow and sluggish circulation in the respiratory organs, with a tendency to congestion and catarrh. The smallness of the lower half of the contracted chest, the tumefaction of the tracheal, bronchial, and mediastinal glands, are also causes of chronic bronchial catarrh or broncho-pneumonia. The dulness over these glands - especially if there is also wasting of the body - may give rise to a suspicion of tuberculosis.

Carmichael regards chronic cough as one of the most common symptoms of rachitis, and considers that, whenever a young infant suffers from that condition, there is a presumption in favour of rickets.

A most frequent complication of rickets is atelectasis - generally in small patches - caused by interference with the proper filling of the pulmonary alveoli during inspiration, although there is no obstacle to expiration; and generally associated with the collapse there is a certain amount of compensatory emphysema. The pressure of the nodules of the rickety rosary almost invariably produces - immediately under the beading - patches of collapsed lung with adjacent emphysema. The lungs are readily affected by bronchial catarrh, bronchitis, broncho-pneumonia, or hypostasis at the bases of the lungs: all these conditions are peculiarly fatal in this disease, and are often the real cause of death of the rickety infant. The malnutrition of the tissues and their general feebleness make the child totally unable to resist cold, and it easily falls a victim to respiratory disorder.

The type of the respirations is often interfered with in rickets. The normal sequence in an infant is a short inspiratory act, a moderately-long expiratory act, and a short pause. It may become inverted, - so that the

expiration is prolonged, the inspiration short and jerky, and the pause abnormally long. The type of breathing is abdominal and inferior-costal. One great peculiarity of infantile breathing is its extreme rapidity and great versatility in type (Ewart). Even when no evident pulmonary trouble is present, the breathing is rapid and shallow, possibly owing to some irritation of the respiratory centre. The rickety child sometimes prefers to go to sleep in a kneeling posture (genupectoral) with its head on the pillow - a position often adopted by patients with cardiac dyspnoea. In rickets, owing to the atony of its muscles, the abdomen usually remains motionless, and protudes very little during inspiration. This, together with the failure of the upper part of the thorax to expand, throws all the work on the diaphragm. The only active respiratory movement is inferior-costal. There is no normal inspiratory expansion, but the action of the diaphragm causes recession of the chest wall, which makes room for re-expansion during the next expiration. This probably must be explained by the fact that the lowered resistance of the ribs and cartilages is more readily overcome by atmospheric pressure than by the imperfect expansion of the lungs (as was first insisted upon by Sir William Jenner), - so that, instead of an increase of the volume of the lung, there is a recession of the chest during inspiration, which can be measured to some extent by the depth of Harrison's groove (W. Ewart, - loc. cit., 1906, p. 921). Very often, owing to collapse and emphysema of the lungs, the rickety child suffers from dyspnoea and cyanosis.

Dukelsky (Arch. Ped., 1904, p. 790) describes a new sign which he found in 9 cases of rickets. He called the condition "polypnoea", or rapid breathing. The frequency of the respiration in rickety may rise to 118 per minute, though usually from 50 to 80 is the average rate. The condition, according to him, is caused by: (1) The presence of carbonic oxide gas, in excess, resulting in irritation of the respiratory centre. (2) The smaller capacity of the thorax. (3) The higher excitability of the central nervous system. He finds that the polypnoea gradually tends to improvement, with the subsidence of the rachitic condition.

Wachsmuth is inclined to regard the lesions of rickets as due to a chronic intoxication by carbonic acid gas.

The interference with free inspiration, and possibly also the impure atmosphere of the surroundings of many rickety children, leads to the frequent development of adenoid growths in the nasopharynx, hypertrophy of the tonsils, and enlargement of the cervical glands. There may also be considerable tumefaction and enlargement of the glands of the trachea, bronchi, and mediastinum - more especially if the child has suffered much from bronchial catarrh. A dull area may be marked out by percussion behind the manubrium sterni, and, if the thymus is increased in size, - as is often the case in rickets, - it can be mapped out upwards into the neck. The wasting and poor health, the dulness on percussion over the lungs, the chronic cough, and the bronchial catarrh, may suggest tuberculosis; and it is possible that these enlarged

glands may sometimes be the cause of sudden death in children. Frequent attacks of bronchitis or bronchopneumonia predispose to tuberculosis, or asthma, in later life. The respiratory disorders may be subordinate to the gastro-intestinal catarrhs; and sometimes a child suffers alternately from these conditions.

It has already been stated that rachitic children can contract tuberculosis, and that the general condition of their health, and the chronic lung troubles, render them particularly liable to this disease. Rachitis, as was formerly supposed, does not protect from tuberculosis.

## CIRCULATORY SYSTEM.

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### HEART AND BLOOD-VESSELS.

The complications arising in the circulatory system are largely of a mechanical nature, produced by the contraction and distortion of the chest wall, as well as by the pressure from below of the abdominal organs. The heart is pushed outwards towards the left, and where it comes in contact with the beadings on a rib, a milk-white patch is formed on the surface of the pericardium. The apex beat may be more diffuse than normal, and pushed outwards beyond the nipple line. The heart muscle shares in the general flabbiness of the muscular tissue, and there may be some hypertrophy of the cardiac organ. The action of the heart is hampered by the abdominal distension, which gives rise to symptoms of palpitation, tachycardia, or slow and irregular pulsations. The arteries throughout the body are dilated; the blood-pressure is low; there is stasis in the principal viscera, as well as at the periphery; and general retardation of the circulation is observed.

Beneke found the pulmonary artery in rachitis larger than in a healthy child; and this would have considerable bearing upon the circulation in the lungs, and also on the pulmonary complications.

There is a passive portal congestion, but, as a rule, no tendency to piles, because the infant is practically always in a recumbent position. The capillary stasis and the lymphatic engorgement lead to enlargement of many of the viscera, - especially the liver and the spleen, - and the irritative proliferation may lead to hyperplasia of the organs. The solid viscera, therefore, may show actual fibrosis of their tissue. The circulation of the blood and lymph within the abdomen is retarded, - partly by the distension of the viscera, but also by the inactive condition of the muscles, which afford no help or stimulus to induce the rapid movement of these fluids in the circulation.

### BLOOD.

The rachitic child is often anaemic, and the blood changes are largely those peculiar to this condition. The red corpuscles are less numerous than in health, and nucleated red corpuscles may be present. There is sometimes a slight degree of leucocytosis. The blood conditions may be complicated by the presence of acute splenic anaemia.

Jacobi alludes to the fact that a great many more blood-cells are required to fill the arteries, when wide,



than when narrow, and affirms that the arteries in rickets are wide and the blood-pressure low. Therefore, if the formation of blood-cells is hampered by any disease of the digestive or blood-making organs, the tissues will then show a relative increase in the percentage of water. This fact has frequently been shown to obtain in examination of the blood of rachitic children.

The anaemic condition, so frequently present in the rachitic, may be set up by an excess of improper alimentation causing auto-intoxication, by the action of cold, or any chilling of the body, producing destruction of the blood-corpuscles, and, in the later stages, by any overtaxing of the strength of the ill-nourished and debilitated child. A disease, such as rickets, which interferes with nutrition to so great an extent, may cause changes in the blood that makes it revert to the more infantile form, in which there is a high proportion of lymphocytes, and only a small number of polynuclear cells. Under these circumstances, enlargement of the spleen may also be present.

### DIGESTIVE SYSTEM.

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Long before the appearance of well-marked rachitic symptoms, the infant suffers from considerable disturbance of the gastro-intestinal tract: constipation, diarrhoea, gastric catarrh, colic, and flatulence may all be troubles of the digestion produced by faulty feeding, which gradually lead on to a condition of malnutrition or of mal-assimilation, and, at a later stage, there is the development of the true rachitic disease. But, on the other hand, these vague symptoms of the digestive disorder may be the actual premonitory signs of the rachitic dyscrasia.

The first symptom of the digestive system, which should arouse a suspicion of the presence of rickets, is obstinate constipation; and, as already mentioned, Jacobi regards constipation, even in a breast-fed infant in the first few months of life, as pathognomonic of rickets. It may be due to atony of the abdominal muscles, with which is often associated acholia with small, dry, pale stools and defective peristalsis of the intestines. Later, there may be acute gastro-intestinal catarrh, with or without diarrhoea and vomiting.

The delay of dentition and the hypertrophy of the tonsils have been referred to elsewhere.

The tongue shows nothing characteristic: it may be quite clean, or thickly coated with fur. If this organ is dirty, and the child is seen to rub its nose or to grind its teeth at night, the mother will wrongly attribute the symptoms to worms; and fortunate will be the offspring that escapes a liberal dosage of worm powders and castor-oil. The surface of the tongue may be slimy, or it may show little islands, - red, marginated, and denuded of epithelium, - "the geographical tongue". These patches increase in size and number, and extend backwards.

Parrot affirmed that they were of syphilitic origin, but this is not correct: for the patches correspond exactly with the erosions near the solitary glands, and those

of Lieberkühn in the intestines; and they may also indicate an incompetency of absorption in that locality, as well as an abnormal secretion.

The large size of the abdomen - almost always a symptom of rachitis - early attracts attention. The rickety child may be brought for medical advice, solely because it has a "pot-belly", with perhaps some slight digestive disorder. This large abdomen (Froschbauch - "frog-belly") is usually tense and tympanitic to percussion, and is the result of manifold causes acting in concert. The atony of the abdominal muscles, the depression of the diaphragm, the contracted thorax, the enlarged liver and spleen, the dilated ~~stomach~~ and intestines, the shallowness of the pelvis, all contribute towards its production.

Comby insists that the big belly is not due to deformity of the thorax, depressed diaphragm, or enlarged viscera, but results most commonly from the dilatation of the stomach. It would seem probable, however, that the atonic condition of the abdominal muscles is an important factor in producing and maintaining this abnormality.

Holt found enlargement of the abdomen in 60 per cent. of his cases. The enlargement is uniform, and the condition is indefinitely kept up by chronic indigestion, flatulence, and fermentation.

The dilatation of the stomach is a common symptom of rachitic children; and it may persist, even into adult life, long after other evidences of rachitis have disappeared. It is not uncommon for rickety children to have an abnormally large appetite, and to suffer from excessive thirst. By the continual overloading of the stomach with food, any gastric catarrh present is aggravated, and the constant distension perpetuates the dilated condition of the stomach. There may be a primary gastric catarrh present, but there is more frequently a secondary gastritis, set up by excessive or injudicious feeding. This leads to the production of mucus and free acid, which interfere with the proper assimilation of food; and this malnutrition is often responsible for the anaemia of the child. The gastric catarrh of rickets invariably is of the acid type; and it is important to neutralise any free acid before the administration of food, - for which purpose alkaline mixtures are very beneficial. In common with all the mucous membranes of the body, those of the stomach and intestines are very liable to catarrh, which is easily set up by cold or errors in diet; it is not amenable to treatment, and relapses are very frequent.

The intestines - particularly the colon - are dilated: this may produce inguinal or umbilical hernia, and prolapse of the rectum is also sometimes observed. Diarrhoea is a constant symptom, continually kept up and aggravated by improper diet. The motions may be acid, green, foetid, slimy, and containing much undigested food; or there may be copious pasty-looking and offensive stools, deficient in bile, with flatulence, fermentation, colic, and abdominal pain. Constipation may alternate with diarrhoea. There is a great tendency for the gastrointestinal disturbances to become chronic - especially if no treatment is directed to the cure of the rickets present. Rickets is the great slime-producer (Angel Money),

and it is possible that its evil effects may still be traced in the mucous disease of older children. There seems little doubt but that the dyspepsias and gastro-intestinal disturbances of rickets persist long after the bony deformities have disappeared, and may be important factors in the production of digestive disorders of later childhood, and even of adult life.

The liver is enlarged: this may be only a passive congestion; later, there is an actual fibrosis of the organ, or changes of a fatty nature set up by obstructed circulation through the lungs - hyperplasia being due to chronic hyperaemia. Catarrhal jaundice sometimes has been known to occur in the course of the disease.

The spleen may be enlarged, and it also may show hyperplasia and fibrosis. Enlargement of the spleen usually indicates the presence of syphilitic disease, or acute splenic anaemia as well as rickets.

The lymphatic glands show great tendency to enlargement and hyperplasia throughout the body.

The bladder is sometimes in a state of catarrh, its mucous membrane irritable, and also liable to infective processes.

Carmichael (Dis. of Childn., p. 177) lays some stress on the frequency of micturition as an early diagnostic sign of rickets.

Analysis of the urine may show little variation from normal specimens. It seldom contains excess of lactic acid; not have later observers been able to detect any increase in the quantity of lime. There may be a strong odour of methylamine.

In a certain number of cases, Fagge (Trans. Path. Soc., Vol. xxxii) has observed an increase in the amount of uric acid passed by rachitic children; but this does not seem to be a constant or an actual symptom of the disease.

#### TEMPERATURE.

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The temperature in rachitis is seldom above normal: it is more often subnormal - especially if the child is suffering from exhaustion or marasmus. There is at times a slight pyrexia with evening exacerbations. But, if there is any marked rise of temperature, it is generally accounted for by some complication of rickets - more especially bronchitis, broncho-pneumonia, or acute gastro-intestinal catarrh.

#### SKIN.

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The changes in the skin are largely those induced by a condition of malnutrition. There is often an increase of the subcutaneous fat, if the child is big and flabby, though, in the later stages of the disease, it may be less than normal, if there has been much wasting of the tissues. The skin is soft and easily irritated, - so that erythematous and eczematous rashes are of frequent occurrence - more particularly about the head and neck: for the excessive sweating keeps up an unhealthy condition of these parts. The skin of the head is moist and perspiring; there may be an excessive secretion of



the sebaceous follicles, leading to seborrhoea, crops of miliaria; and, if the toilet of the head is neglected, there will be impetiginous eruptions.

The hair, instead of possessing the bright appearance and the glossiness of health, is often dull, dry, meagre, and wispy in quantity, and thin, poor, and of unsatisfactory quality.

Strophulus, and kindred eruptions about the mouth, are often wrongly attributed to teething. There may be eruptions of eczema, impetigo contagiosa, or lichen about the body; and, if there is much gastro-intestinal disturbance, urticaria - in an acute form suggestive of a toxæmia - may put in an appearance.

Irritable eruptions - such as prurigo or pruriginous strophulus - are sometimes observed; the latter is characterised by an eruption of discrete papules surmounted by vesicles. The frequent scratching of the lesions of prurigo may result in bleeding; and, if this trouble is left untreated, it may merge, in after life, into the chronic prurigo of Hebra - an almost incurable disease (Comby).

The diarrhoea and the acid slimy motions scald and irritate the buttocks, genitals, and the backs of the thighs, - so that, in these parts of the body, various eruptions are nearly always present - the most common being erythema, eczema, impetigo, and echthyma. The last-mentioned eruption may leave scars, so deep and permanent that they may even suggest the presence of hereditary syphilis.

Trophoneuroses, conditions of local ischaemia, coldness and cyanosis of the extremities have been observed.

Continual scratching may cause infection of the skin, which may lead to boils, enlarged glands, and subsequent suppuration.

Cutaneous eruptions are not found in all cases of rickets: for frequently children with this disease have a skin that is healthy, white or mottled in colour, and free from blemish.

There may be a condition of general hyperaesthesia; but this should suggest more often the presence of scurvy - either alone, or as a complication of rickets.

#### INFECTIOUS DISEASES.

The standard of nutrition in a rickety child is so low, and its vitality so feeble, that it easily falls a victim to concurrent diseases. Broncho-pneumonia or acute diarrhoea, occurring in a rachitic infant, are especially liable to prove fatal. It also very readily falls a victim to infectious diseases, and contracts these affections with greater frequency than healthy children. The rachitic apparently has no power of resisting any infective virus.

The mortality of rickety children from measles, diphtheria, scarlatina, enterica, and influenza is very great. Unfortunately, this disease is seldom mentioned in the death certificates, - so that it is practically impossible to arrive at any accurate statistics. Whooping-cough is a disorder that must be regarded as

of the utmost gravity, if it occurs as a complication of rickets: for the child is unable to cope with the sudden spasmodic attacks of pertussis, because it is hampered by the contracted thorax, the feebleness of its muscles, and the special tendency present for collapse of the lungs. In this disease, fatal syncope is not uncommon.

Hansemann (Berl. klin. Woch., Feb. 26, and March 5, 1906) especially emphasizes this remarkable predisposition to infectious diseases shown by rachitic children, and states that his records seldom show deaths from diphtheria, scarlet fever, or measles, unless the patient also has rickets, and that this fact is particularly noticeable in regard to whooping-cough. He regards rickets not as a bone disease, but as a disease of metabolism; and he points out that, as renal affections are associated with gout, in a similar manner pulmonary and intestinal catarrh occur with rachitis. This, however, is no new theory: for Fagge and Sir William Jenner, many years ago (Trans. Path. Soc., Vol. xxxii) seemed inclined to regard rickets as a diathetic condition, comparable to gout.

Tuberculosis, in whatever form, grafted on to rickets, is almost certain to result in the death of the child.

#### CHLOROFORM POISONING.

Though the subject does not really come under the heading of Symptomatology, it is perhaps not altogether irrelevant at this juncture to refer to the effect of chloroform on rickety children. It seems possible that many of the deaths, now classified as due to delayed chloroform poisoning, have as their predisposing condition the presence of rachitis.

E. Telford and J. L. Falconer (Lancet, 1906, p. 1341) report two cases of death after chloroform in markedly rachitic children. Guthrie believes that a predisposing condition is always present, on which the chloroform has heaped the last straw; and the above-mentioned writers suggest that in rickets will be found one of these predisposing conditions. They also refer to notes on other cases, - all osteotomies for rachitic deformities, - in which symptoms pointing to delayed poisoning by chloroform occurred; and they note that additional cases are to be found in the literature of the subject, in which the patient suffered from the symptoms or sequels of rickets.

It is possible that the toxæmia of rickets produces some change in the tissues, or that there may be some fatty condition of the liver which renders the child peculiarly sensitive to the poison of chloroform, though it may only be that rickety children, in common with all children of a lymphatic temperament, take chloroform very badly. This peculiarity is worthy of mention; for it is possible, and even an additional source of danger to the rachitic child - especially if it is necessary to submit it to any surgical operation.

#### ACUTE RICKETS.

It is doubtful whether rickets ever assumes an acute form. The usual type of rickets seen in an infant develops slowly, and its full effects, - as evidenced by

the deformities of the limbs, the disturbances of the respiratory and gastro-intestinal organs, and the varied symptoms of a nervous instability, - do not appear fully matured until after many months of vague premonitory disorders.

A disease, however, has been described, in which a succession of symptoms, not unlike those of rickets, appear with startling suddenness, and which is classified by many authorities as an acute form of rickets. The affection has also been regarded as a multiple epiphysitis or periostitis of the articular ends of the long bones. The disease may appear suddenly, and its effects on the child are so severe that, though in perfect health immediately prior to being seized by this illness and apparently showing no sign of impending ailment, it is speedily reduced to a dangerous condition of marasmus and exhaustion.

The principal symptoms described under the name of acute rickets are fever, anaemia, swelling of the epiphyses, tenderness on pressure or movement of the joints and limbs, extravasation of blood under the periosteum, proptosis of the eyes, oedema or ecchymoses of the eyelids, as well as passage of blood by the bowel or haematuria. The acuteness of the disease, the pain, the tenderness and swelling of the limbs almost suggest some septic disease - such as osteomyelitis or rheumatic fever. Latterly, most authorities do not regard the affection as one of rachitic origin.

The investigations of Barlow and Cheadle almost conclusively prove that the disease is not rickets at all, but infantile scurvy (an affection often associated with rickets); and it is possible that this combination has given rise to the misapprehension of the true nature of the scorbutic condition, wrongly termed acute rickets.

Holt and Cheadle strongly deny the occurrence of an acute form of rickets; on the other hand, other authorities are not so positive, and, though agreeing that the condition may be scorbutic in origin, they incline to regard it as an intense form of anaemia present in severe rickets.

Ashby (Dis. of Childn., p. 370) states that there is much in favour of this latter view. Acute rickets may resemble congenital syphilitic epiphysitis. This usually occurs under six months of age, and may be a foetal condition. The presence of other signs of syphilis, as well as the absence of the characteristic haemorrhages, should serve to distinguish the syphilitic disease from the rachitic (or scorbutic) condition.

Hutchinson (Dis. of Childn., p. 112) advises an avoidance of the term "acute rickets", as liable to lead to confusion with scorbutus, but admits that a class of cases can be seen, marked by a rapid onset of the disease, with the development of visceral, rather than osseous symptoms, and characterised by tenderness over the bones, as well as by a tendency to sweating.

In examining the reports of cases appearing during recent years, it is noticeable that almost all are classified under the heading of scorbutus, and are only incidentally referred to as cases of so-called "acute rickets"; indeed, it seems that most authorities are abandoning the use of the latter name.



FOETAL RICKETS.  
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Recent researches rather incline towards disproving the alleged occurrence of rickets during foetal life, and to classify cases, previously reported under this heading, amongst the diseases of osteoporosis or osteogenesis imperfecta.

Comby says: "One is not born rachitic, one becomes so". According to this writer, foetal rickets, - with its deformities, its multiple fractures, and its anomalies of ossification, - presents a number of unrelated phenomena, which do not belong to true rickets.

It is also supposed that many of the infants born stunted and deformed, and reported as foetal rickets, were probably really cases of achondroplasia foetalis - a condition first clearly described by Parrot, in 1878, who insisted that the condition was due to a defect in the development of the cartilaginous bone.

Before this date, however, obstetricians always classified these cases as foetal rickets, though, even in 1856, Virchow had drawn attention to the large head and short limbs of a certain number of fetuses.

Winkler, in 1871, differentiated the condition from ordinary rickets, and proposed to call it "rachitis micromiela". Depaul also insisted that achondroplasia and rickets were two separate diseases.

Kauffmann was the first to use the rather clumsy name of "chondrodystrophia foetalis"; and Müller, Porak, Knebbing, Marchand, and Pierre Marie also added to our knowledge of the disease. The last-named authority gives an instructive contrast of the measurements of the body in two cases of achondroplasia with a normal child of eight years.

Porak and Duranti (1894), in the case of a newborn child apparently rachitic, found a marked rarefaction of the bones, a dilated medullary canal, filled with marrow and surrounded by a thin layer of bone.

There is extensive resorption of bone; and this condition is not to be found in true rickets. Microscopical examination of the bone shows that the defective growth is due to a rudimentary and irregular arrangement of the proliferating cartilage cells, and an ingrowth of connective tissue from the periosteum, between the diaphysis and epiphysis, which separates them completely. There may be synostosis of the sutures at the base of the skull. In achondroplasia the limbs are short, stunted, and bent; the head is large, but its bones, as well as those of the chest, show no deformities. The fingers are equal in length, and spread out at their distal extremities, forming the typical "main en trident". It seems fairly certain that a proportion of the cases of foetal rickets should be classified under achondroplasia, which also must be regarded as a disease of foetal cartilage preceding the period of bone-formation, and as having no relation to true rickets.

The infants born suffering from so-called foetal rickets are found to have the bones of the skull, ribs, and limbs imperfectly calcified, enlarged epiphyses, and to sustain fractures from any injury, or even under most careful handling, or during examination.

Henry Ashby (Rep.Soc.Dis.Childn.,Vol.i,p.166) reports the case of an infant,well nourished at birth, who,during the first fortnight of life,had five fractures,- right humerus and radius,left humerus,ulna,and femur,- and,at six ~~weeks~~ of age,when being examined,sustained a fracture of the right femur.At two weeks of age,there were symptoms of rachitis present:craniotabes of the parietal and occipital bones,softened ribs,broad vertical grooving of the chest,beaded ribs,but no enlargement of the epiphyses.

Comby quotes Chaussin as having reported the case of a foetus,in which there were no less than forty-three fractures.These cases,however,should be classified as osteogenesis imperfecta,and not as foetal rickets.

The experiments of Chalmers Watson,previously quoted,show that parent rats,fed on an excessive meat diet,developed symptoms identical with those of rickets. Anatomically,the changes were those of advanced rickets in the human subject;but microscopical examination showed that the condition was widely different,the histological appearance not that of rickets,and the epiphyseal lines not presenting the irregular dentate appearance so characteristic of this disease. Other experiments with animals appear to have given very similar results.

Stoeltzner fed a puppy on horseflesh,bacon,and distilled water - the result being that the animal increased in weight,the bones became bent,and the epiphyses enlarged.The condition apparently resembled rickets,but the bones were very spongy;and it is doubtful if this authority can claim to have really produced rachitic disease in the way he describes.

R. Lovell and E. Nicholls (Brit.Med.Jour.,Oct.13, 1906,p.915),in a paper on osteogenesis imperfecta,held that the preponderance of evidence is against the occurrence of rickets in intra-uterine life.They give as the essential features of osteogenesis imperfecta: (1) A process of bone-formation,everywhere checked,and of an abnormal kind. (2) Metaplasia of cartilage,greater than normal,while the apposition of bone is much less. (3) Formation of periosteal bone,which is abnormal and incomplete. (4) Deformities due to (a) imperfectly united fractures, (b) curving and bending of the bones due to the disease itself,and which have led to the erroneous idea that rickets was present.

Ashby (loc.cit.,p.169) points out the difference between rickets and osteoporosis.In rickets there is a very extensive preparation for ossification,a rich formation of osteoid tissue,which,with no scarcity of lime salts,remains uncalcified;in osteoporosis very slight preparation for ossification takes place,but, though there is a scarcity of lime salts,the osteoid tissue is calcified,and,in opposition to rickets,there is calcification of the cartilage matrix.

The etiology of foetal rickets is obscure,but there seems a close connection between the health of the mother during pregnancy and the foetus at birth.If the mother has suffered from starvation,want,or any acute illness,the foetus may be born with this disease.

The experiments of Chalmers Watson on rats still further support this statement;and his case,in which a

child, born of a tuberculous mother, fed on excessive meat-juice months before marriage, which developed a similar disease, strongly suggests that causes are in operation in the parent ready to act at the conception or birth of the child.

Charrin and Gley, quoted by Ashby, claim to have produced congenital rickets in a rabbit, by injecting the parents with the toxins of diphtheria and "blue pus".

Chalmers Watson considers that special attention should be directed to the condition of the thyroid, adrenal, and other glands: for, according to the paper of Dr. Lovett and Nicholls, the children may show a cretinoid condition of the face, and have small adrenal glands; and he further advises that, in addition to the examination of their structure, due regard should be paid to the weight of these organs in relation to the total body weight.

If, as seems probable, foetal rickets is osteoporosis, much information may be gained in the future by a careful inquiry into the history of the parents, the state of their health, and any peculiarities in their diet.

Cases that cannot be classified as osteoporosis will probably come under achondroplasia or cretinism; and the name "foetal rickets," being a misnomer, will fall into disuse.

The differential points between rickets, achondroplasia, and cretinism will be referred to under Diagnosis.

#### LATE RICKETS.

Although rickets is almost entirely a disease of infancy or early childhood, yet, sometimes it is seen in later life. It may appear at the period of puberty, or even in adult years. About the age of puberty, both growth and ossification attain an intensity only equalled, or surpassed, in the first two years of life, and the condition of the osseous system is similar. The name "prolonged rickets" has been used by some writers to indicate cases of infantile rickets, which have persisted, with intervals of intermission, up to or beyond puberty.

H. Clutton is inclined to regard adolescent rickets as a distinct development of infantile rickets, arising in circumstances which are chiefly due to the age of the patient.

Rickets is a disease associated with growth and development; and it is somewhat rare for it to occur after the epiphyses have ossified. As a rule, late rickets is confined to the growing limbs; and the head is scarcely affected, because in it growth and expansion are almost completed. In some cases, there is a history of rickets during early years, then a long interval of health with no relapses, but the appearance of late rickets at puberty.

Ollier divides cases into (1) those in which rickets appears in adolescence (primary rachitis tarda), and (2) those in which there is a relapse or a recrudescence of the disease at puberty, after an apparently complete recovery from an attack in infancy (secondary rachitis tarda).



Goodhart and Still adopt a different classification, and mention three varieties: (1) Cases identical with ordinary rickets. (2) Cases with atrophy and fragility of the bones like osteomalacia, these same forming the majority. (3) Cases unlike (1) or (2), but possessing peculiar features of their own.

Trousseau makes no distinction between rickets and osteomalacia.

The principal symptoms in a case of late rickets, occurring before puberty, is a condition of fatigue induced in a child, even with the excitement of very slight exertion. The child may also suffer from excessive perspirations. The muscles and ligaments are lax, the epiphyses slowly enlarge at the wrists and ankles, there is stiffness of the legs, and some pains in the muscles and bones. At a later stage, the deformities usually associated with rickets appear: lateral curvature of the spine, knock-knee, flat-foot, beading of the ribs, and a waddling gait, or a walk suggestive of hip-joint disease. The pelvis, as in early rickets, is flat. There may be hypertrophy of the muscles. The patient may show diminished stature; and it appears that one of Clutton's cases only weighed 6 st. 5½ lbs, though the height of the patient was 5 ft. ½ in. Nervous symptoms also are present. The child is irritable, restless at night, unfit for school or work, and may suffer from depression or hypochondriasis.

Professor E. Roos considers that the cardinal symptom in rickets is enlargement of the epiphyses; and also that simple deformities - such as genu valgum - are insufficient evidence of the disease.

Mickulicz, however, calls attention to the fact that so-called genu valgum adolescentium is usually only a characteristic of late rickets. He could find no constant relation between knock-knee, the second decade of life, and long-standing, or the carrying of heavy weights, - which same many surgeons assign as the cause of this condition.

A considerable number of cases of late rickets have been reported.

Dr. Drewitt (Trans. Path. Soc., Vol. xxxii, 1881) narrates that of a boy, aged 10½ years.

Koplik (Dis. of Childn.) saw the condition in the case of a female of 8 years.

E. Roos (Zeit. f. klin. Med., Bd. 41, H. 1, p. 11; Med. Rec., Vol. vi, p. 237) had two cases - the first, a girl of 11, without history or signs of early rickets; and the second, a girl of the same age, who had rickets when a year old.

Cheadle (Trans. Path. Soc., 1881) had occasion to treat a boy, aged 9, for this affection; and this he did by anti-rachitic diet, but without appreciable benefit.

John Thomson (Edin. Med.-Chir. Jour., 1903; Lancet, July 4, 1903) tells of its occurrence in a child of 8 years, whose weight was 22 lbs, the patient having been breast-fed for eighteen months, and walking for about a year. There were no signs of rickets until eighteen months previous to the appearance of the present disease. This was ushered in by an attack of diarrhoea, followed by muscular debility, deformity of the chest, and rickety rosary. Skiagraphs showed a great deficiency of lime salts in the bones.

Robert Hutchinson (Trans.Soc.Dis.in Child.,Vol.v, p.181) attended a boy of 9 years and 8 months for bending of the legs.He was breast-fed up to the age of eight months,and has rickets when three years old,from which he never properly recovered.It was suggested that this was a case of continuous rickets with exacerbations; but our author considered that the case differed from persistent rickets,because the boy got worse during the last five years - both with regard to curvature and the thickening of the bones.

Drey (Monats.f.Kinderh.,May,1906) reports the case of a girl,aged 7 years,who,four months previously,had pain in walking.Since the onset of the pain there was development of marked enlargement,and deformity of the epiphyses.During twenty years,Drey had observed 50,000 rachitic children,and had only found five cases of rachitis tarda.Those cases appeared as a continuation of early rickets with subsequent deformity.If the disease came on suddenly in a previously healthy child,he preferred the name of rachitis adolescentium.These cases he had seen,for the most part,in girls between the ages of twelve and fifteen years.

The etiology of the condition is obscure;and examination of the cases does not always confirm a diagnosis of rickets.With the assistance of the X-rays,it is now possible to make a more accurate diagnosis of the disease during life.Overexertion and fatigue are supposed to contribute to its causation:it explains the localization of the disease,but not its etiology.Improper food,or bad hygienic conditions,adversely influence the disease - just as is the case with ordinary infantile rachitis.

Clutton points out that the disease frequently appears at a time of great intellectual stress (12 - 14 years),owing to the demands of school and education upon the system.It is probable that the higher nerve centres,unemployed during infancy,become developed at puberty,and interfere with metabolism.The first of Clutton's cases was accustomed to walk three miles backwards and forwards between his house and school every day for several years.He also worked late very night,in order to prepare for a scholarship,which he succeeded in winning;the second case,a girl,was in the sixth standard of school between twelve and thirteen years of age. The intelligence of the cases is usually quite up to or above the normal standard of their age.Prolonged mental strain may be,however,a factor of considerable significance and importance.Premature sexual development has been noted by Clutton;and sexual causes may be at work in the production of the disease.

Dr. Marsden showed,at the Manchester Medical Society,a case of late rickets - a female of the age of 18½ years. The skiagrams (Lancet,1904,p.1835) showed a remarkable increase in the breadth of the epiphyseal cartilages;and Dr. Marsden suggested that this might be a more trustworthy sign of late rickets than the enlargement of the ends of the long bones.He classified late rickets into:

- |                   |                |
|-------------------|----------------|
| (1) Disseminated. | (2) Localised. |
| (a) Primary.      | (a) Primary.   |
| (b) Secondary.    | (b) Secondary. |

He expresses the opinion that rickets is due to an absence of the conditions necessary for healthy growth, and that faulty nutrition, or bad hygienic surroundings, by their influence on the blood, so altered its characters that it was prevented from serving its proper function, thereby engendering rachitic disease.

A. Pollosson and Broca have noted, in cured rachitis, the persistence of pearls of cartilage in the middle of the epiphyses; and it has been suggested that these granules may explain the late deformities of rickets.

Late rickets is sometimes described under osteomalacia; and it is important to distinguish it from this disease.

Goodhart and Still suggest that rickets and osteomalacia may be the same disease, but with different processes in the ascendant.

Osteomalacia is a disease of adult life; it affects women more frequently than men 10 : 1; and is usually seen between 25 and 30 years of age. It occurs most frequently in pregnant women - more especially in multiparae; and the first evidence of the disease appears in the pelvis, though all the bones of the body - especially the ribs and extremities - may be affected. The sacral promontory is pushed forwards, and the pressure of the femora approximates the pubic bones, giving the pelvis a beak-like form. The bone becomes soft and decalcified, as if it had been treated by hydrochloric acid, and there is subsequent absorption of the animal basis by the hypertrophying marrow. The result of the absorption of the lime salts is that the bones are only thin-walled and brittle shells, full of red marrow, or the bones may disappear completely, and only periosteum remains around the marrow. There is even a greater amount of decalcification than in rickets, and there is also found present an excessive amount of fat. The urine always contains an excessive amount of lime salts. Fractures are common; but, so long as bone is present, they heal readily.

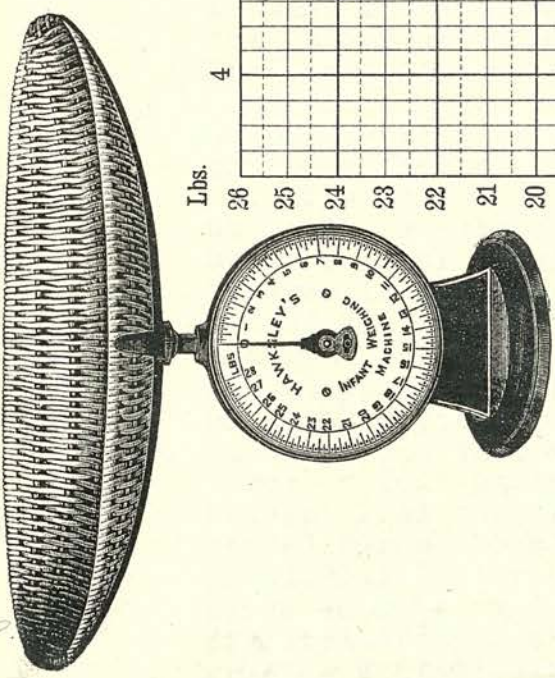
Osteomalacia may be distinguished from late rickets by its frequent occurrence in the pregnant female; by the fragile shells of bone filled with marrow and an excess of fat; by the characteristic beak-like pelvis; and by the normal appearance of the epiphyses. In cases of doubt, Marsden's suggestion, that broadening of the epiphyseal line (seen in the skiagram) is a reliable sign of late rickets, may help the diagnosis.

The treatment is unsatisfactory. Rest in bed, attention to the diet, good food, fresh air, salt baths, phosphorus, and cod-liver oil may all help towards a cure. Iodide of potassium, even though there is no syphilitic history, may exert some favourable action. Thyroid extract has been tried; but, so far, it cannot be said that treatment by this method alone offers hope of success.

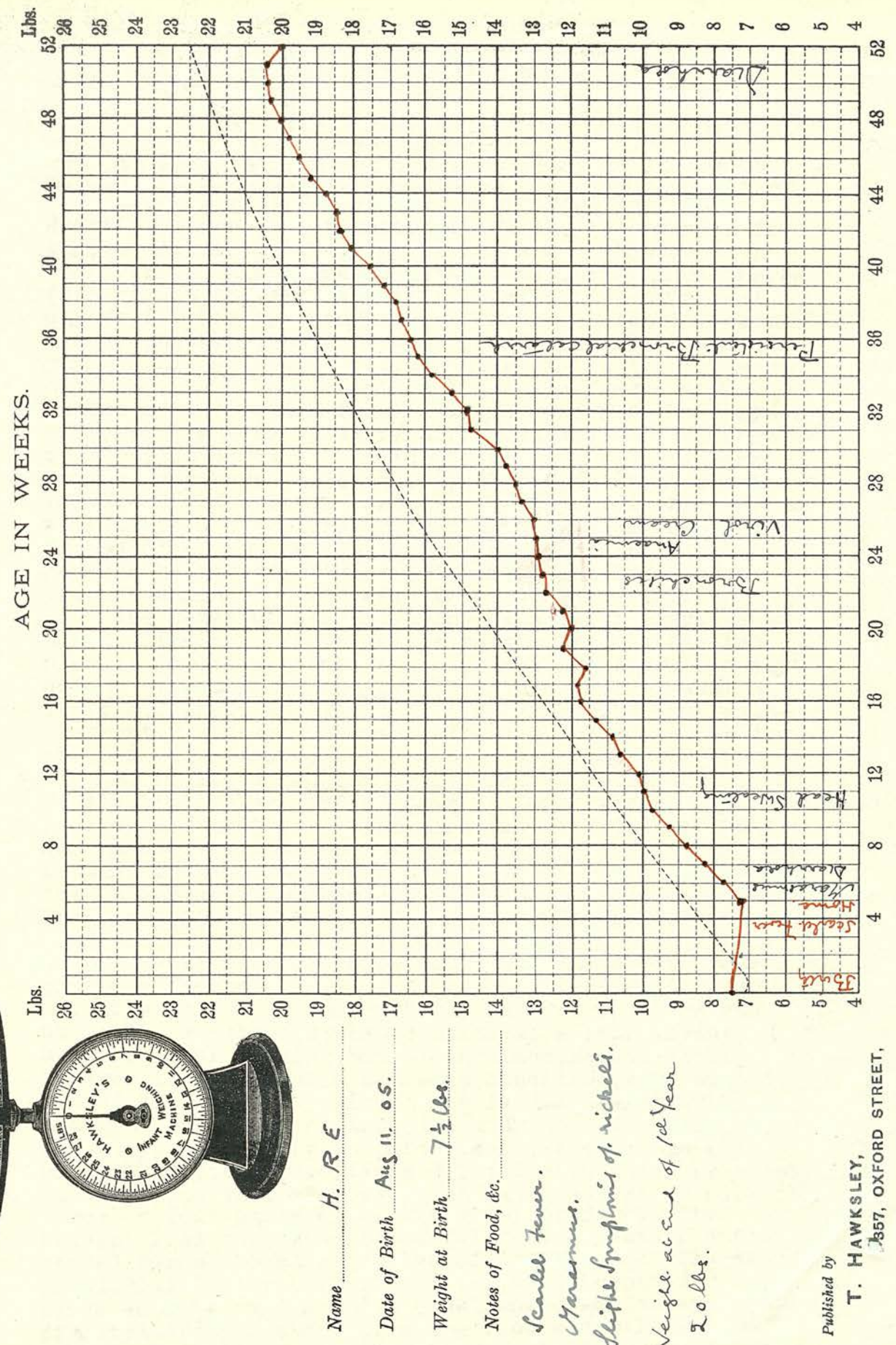
Clutton advises that any correction of the deformities, by osteotomy, should be postponed until all signs of rickets have disappeared.

It is necessary to diagnose late rickets from persistent rickets, which, Jackson Clarke says, is fairly common at orthopaedic hospitals: for he appears to have seen it in children from 8 - 14 years of age (Rep. Soc. Dis. Childn., Vol. v, p. 182).





# *Case suggesting Early Rickets.* CHART TO SHOW INCREASE IN WEIGHT DURING THE FIRST YEAR.



Name *H. R E*

Date of Birth *Aug 11. 05.*

Weight at Birth *7 1/2 lbs.*

Notes of Food, &c. ....

*Scald fever.*

*Measles.*

*Slipsh symptoms of rickets.*

Weight at end of 1st Year  
*20 lbs.*

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LONDON.

DOTTED LINE SHOWS AVERAGE WEIGHT AT DIFFERENT AGES.



# CASE SUGGESTING EARLY RICKETS

## WITH WEIGHT-CHART FOR THE

### FIRST YEAR OF LIFE.

In private practice it is not easy to follow up cases showing suspicious symptoms pointing to early or late rickets. If the case is one of bronchial or gastric catarrh, or of ~~malnutrition~~ due to improper feeding, the services of the physician are dispensed with whenever convalescence is established. Doubt must therefore remain whether rickets was truly present or not, unless further opportunities of following up the case are forthcoming. The expense of a medical attendant prompts his earliest possible dismissal; but, if only children could be narrowly watched and frequently inspected during the first two years of life, many minor ailments might be speedily corrected, and the tendency to rachitic disease checked before much harm had been done. Many parents take their children, at regular intervals to the dentist, in order to be satisfied that all is well; it is a pity, however, that this wise rule is not extended, and the medical man asked to advise on the general health of growing infants and children, after proper examination, at least four times a year.

The notes of the following case (with chart) show how difficult it is to determine whether rickets is present in its earliest stage or not. The diagnosis may be one of simple atrophy, yet, symptoms were present during the illness and early life of the child that made the writer strongly suspect a tendency towards the development of rickets.

H. R. E., a healthy child when born, then weighing  $7\frac{1}{2}$  lbs. His mother died of scarlet fever, during the puerperium, which the child also contracted, - so that he was removed to the hospital forthwith. During his sojourn in that institution, a great variety of foods was tried, and he was given a considerable amount of stimulant. Nothing suited, or possibly received a sufficient trial; he suffered from vomiting and diarrhoea, and, on his discharge from the hospital and return home, his weight was only  $7\frac{1}{4}$  lbs.

The writer did not see the patient until he was about two months old, when considerable improvement, under careful nursing, had taken place. He was still, however, in a miserable marasmic condition, very wasted, and unable to wholly digest his food satisfactorily. He had much colic, indigestion, and diarrhoea. The stimulant was stopped entirely, and, after, some experiments with milk, in varying proportions diluted with water or gruel, it was found that the best food was one part of milk to three or four parts of a thin gruel, prepared from Neaves' Food, one dessertspoonful to one pint of water, cooked for at least a quarter of an hour, and milk-sugar added. Plain water or barley-water, as diluents, did not agree so well as the above gruel, which was always easily digested. After a short time the food was milk - 1 part, gruel - 2 parts, slowly increased to half-and-half; and this was the basis of the dietary for the greater part

of the first year. It may be noted that the baby was always given fresh milk, and only boiled milk if specially ordered during the hot weather, or for digestive disorder.

The child was at first ravenously hungry, and required more food than is usual for its age; it was also necessary for some months to feed him every four hours during the night. The digestive troubles ceased, the weight slowly increased, and the child began to make headway, and, even though it had a smart attack of diarrhoea, there was no fall in the weight-curve. Graduated doses of cream (maximum dose - one teaspoonful) were added to alternate or every feed of six ounces.

At about three months, sweating of the head was noticed. This was always very profuse about the head and neck (never on the body), and the child was restless - always kicking the bedclothes off at night, and lying uncovered. At a later date, head-rolling was observed, and the hair on the occiput was almost worn away by the continual friction. The head sweating and restlessness continued up to the ninth month.

There was slight thickening of the epiphyses, and, a little later, curvature of both tibiae. Beading of the ribs was not marked, but there was a slight indication of a lateral furrow round the chest. There may have been a little thickening of the frontal bones, but this was never regarded as a real symptom. The muscles, owing to the child's atrophic condition, were flabby and wasted. The infant was very nervous, and a restless sleeper throughout the first year - long after it had ceased to suffer from colic and indigestion.

Between the fifth and sixth months, anaemia was a very distinct symptom (even the mucous membranes of the lips were blanched), and gave rise to considerable anxiety.

Iron had no influence on the condition, but it rapidly disappeared when Virol was added to the dietary. After some experimentation, the writer found that the best way to give the Virol was to add one or more teaspoonfuls - according to the age of the child - to one pint of gruel at a temperature of 100°F., keeping same at this heat for fifteen minutes. This was made twice in the twenty-four hours. The malt-extract thinned and dextrinised the gruel, and rendered it more digestible; the bone-marrow was readily absorbed, and gave rise to no gastric disturbance. The portion of milk in each feed remained unaltered, and cream was added as required. Every effort was made to obtain clean milk; it was delivered in stoppered bottles, and poured into a clean vessel immediately on receipt, covered, and kept in a cool place.

Very shortly, on this treatment (without any drugs) the anaemia disappeared; and but little alteration was made in the diet up to nine months of age, except to increase the quantity of milk in the feeds. Afterwards, the gruel was slowly thickened. About the sixth month, head-banging was observed, and was probably due to an erupting tooth: for the first lower central incisor was cut at six and a half months. There were no signs of



middle-ear disease. The teeth were cut at the normal dates, and with little discomfort; but the right lateral upper incisor was cut before the upper central incisors. The infant had two attacks of bronchial catarrh: the first attack when five months old, with some fever. The weight was then 12 lbs. 12 ozs., and there was also a gain of 3 ozs. during the next two weeks. The second attack, at eight months of age (weight 16½ lbs), was very persistent, though there was only slight rise of temperature, no fall in the weight-curve, and no impairment of the child's vitality.

After seven months, there were no very obvious symptoms of rickets, except sweating of the head, restlessness at night, and slight bowing of the tibiae. The child frequently adopted the genupectoral position when it went to sleep. The muscles began to gain tone and firmness, and filled out rapidly; the child was never fat, always spare and cleanly built, and the complexion was that of health. The patient was well, bright, and happy, it sat up and took notice of its surroundings; it seldom had colic or indigestion; and the feeding at night became unnecessary.

Its weight at one year old was 20 lbs. The mental activity and intelligence of the child was acute, and remarked upon by disinterested observers; it has always been extremely vivacious, and is quick at noticing or imitating the actions of people around it. Nevertheless, talking and walking were a little delayed. It was able to say two words at 17½ months, and began to walk towards the latter end of this month. It could stand fairly well against a support; or crawl on the floor, by the end of the first year.

The writer was of the opinion that this case showed a tendency towards rickets - even though most authorities assert that atrophic infants seldom become rachitic. The child, after its period of early illness, was in the best possible surroundings; it was nursed in an ideal way, and all details with regard to its food were attended to with scrupulous exactitude. Any indication of gastro-intestinal disturbance was met by immediate alteration (if required) of the strength of the food. In addition, the child had an abundance of the very purest of air.

The air of Hoylake is sharp and bracing, the village is situated at the mouth of the Dee and on the Irish Sea. The air (often strong and westerly gales) comes over the Welsh hills from the Atlantic Ocean, and is keen and invigorating. The baby was made an open-air child; it was out winter and summer; and, whenever possible, it slept out of doors during the day. At the present time it does not appear at all inconvenienced by cold weather. Drugs were seldom used in the treatment of the case, reliance being placed on the diet, the fresh air, and the nursing.

The only reason for alluding to this case is to emphasize the statement that it is difficult to make an accurate diagnosis in the early stages of rickets, that any suspicious symptom should be regarded as a danger-signal, and the case treated as if rickets had fully developed.

Fortunately, in this case the writer was able to have unlimited opportunities of studying the child (as it was a relation), and therefore could watch and estimate its progress week by week for the whole period of eighteen months. Until the first tooth appeared at six and a half months, he felt confident that he was dealing with a case of early rickets, and even now believes that the child was only saved from drifting into the osseous changes of the disease by the excellent nursing, and the open-air life with abundant fresh air (often impregnated with salt and ozone) and sunlight.

Measurements and Condition of the Child at 17½ Months.

Height - 32½ inches.

Circumference of head - 19 inches.

" of thorax - 19½ "

" " abdomen - 18½ "

Weight - 24 lbs. 6 ozs.

Anterior fontanelle almost closed.

Number of teeth - 14.

Slight thickening of the wrists and ankles.

No beading of ribs, or deformity of chest.

Distinct bowing of the left tibia in its lower third, and slight weakness of the ankle-joint.

Muscles firm and hard.

The child is well nourished, has bright-red cheeks and lips, good appetite, normal motions, sleeps well (occasionally slight night-terrors), and is very active and intelligent.

The diet is still carefully supervised, and Grape- or orange-juice given daily.

EYES AND TEETH.

Rickets may be associated with lamellar or zonular cataract. The cataract is supposed to develop early during the formation of the lens; it may be foetal, but probably is developed during the first year of extra-uterine life. Many cases, supposed to be congenital, are really formed during the period of dentition.

The cataract consists of a layer of opaque substance in an otherwise transparent lens; the nucleus and cortex remain transparent, it being the lens substance which develops before and after the disturbance of nutrition caused by rachitis. The layers of the cataract may be multiplied. Zonular cataract is sometimes unilateral, though more frequently it is bilateral. It develops in children, who have convulsions during primary dentition, but it is also seen in cases which have no history of convulsions or suspicion of their occurrence. The mother may state that the child never had fits, but further inquiry may elicit the fact that there has been crowing inspirations (laryngismus).

A peculiarity of the teeth, seen in the second dentition, is seen in association with zonular cataract. They are frequently confused with the syphilitic teeth of Hutchinson (peg-top incisors), but they differ entirely therefrom; the malformation of the rickety tooth is essentially an arrest in the development of the enamel,

whereas the syphilitic tooth (apart from any other cachexia) is pegged, and has good enamel. The two varieties of tooth may occur together, if the rachitic child has also had syphilis. The rachitic tooth has sometimes very little enamel, the rough dentine looking as if it had been pushed through a sheath; or the condition may only be shown by two or three dotted grooves, parallel with the free border, giving the tooth a worm-eaten appearance.

The writer's father had opportunities for seeing great numbers of these rachitic teeth in the practice of the Liverpool Eye and Ear Infirmary, and, as they resembled in appearance cliffs that had been eroded by the action of the waves, he found it convenient to describe the tooth of rickets as the "tidal mark" tooth, in order to distinguish it from the syphilitic or "screw-driver" tooth (Edgar Browne, - Zonular Cataract and Dental Malformations, Ophthalmic Review, 1886).

It is probable that this early dental decay is associated with a deficiency of lime salts in the teeth. As a general rule, it may be stated that, if the cataract and the teeth are associated, convulsions will invariably occur; but, if there is no erosion of teeth, there is probably no history of convulsions.

#### SHORT NOTES ON SOME CASES OF RICKETS.

##### I. RACHITIC SPINE.

J. M., aged 3 years, was brought for the treatment of a "spinal disease". There was well-marked kyphosis in the dorso-lumbar region, but no rigidity of the erector spinae muscles, or tenderness on manipulation. On putting the child in a horizontal position, the curve disappeared. Other signs of rickets present were the square rachitic head, anterior fontanelle still open, beading of the ribs, and curvature of the tibiae. The condition entirely disappeared under anti-rachitic treatment.

##### II. CATARRHAL TYPE - BRONCHIAL AND VISCERAL.

M. K., aged 18 months, had repeated attacks of bronchitis. He was still breast-fed. At 10 months, frequently suffered from diarrhoea and vomiting; at 15 months, this ceased; and, since that time, the child has had repeated attacks of bronchitis. Other signs of rachitis present are marked enlargement of the lower epiphyses of the tibia, considerable delay in dentition, bowing of the femora in an antero-posterior direction, and profuse sweating of the head at night.

##### III. CATARRHAL TYPE ASSOCIATED WITH NERVOUS SYMPTOMS.

W. F., aged 2 years, artificially fed from birth. Up to the end of the first year, diarrhoea has been a troublesome symptom, and subsequently he had frequent convulsions. When 13 months old he had a very severe convulsion, and died. There was marked curvature of the tibiae, enlargement of the epiphyses of the wrists and ankles, and the anterior fontanelle was widely patent.

##### IV. ANAEMIA OF RICKETS.

F. W., aged 15 months, brought for advice, by the mother, on account of marked languor and pallor. She was artificially fed, and had been given "sop" from the age of 5 months onwards. The child had a typical rickety head, protuberant abdomen, and the bones of both the



forearms and legs were curved. The liver was enormously large, and the spleen was palpable, but there was no history of syphilis. The mother was a healthy woman, and had had five children, all of whom were alive and healthy. These children were all breast-fed up to 10 months. During her last confinement, her milk had left her on the fourteenth day. Her husband is a strong and vigorous man, who affirms that he has never had a day's illness in his life.

#### V. PSEUDO-PARALYSIS.

W. A., aged 18 months, brought on account of paralysis. He had made no attempt to walk, and, when placed upon his feet, could scarcely stand. There was marked kyphosis of the spine, and enlargement of the epiphyses, but there were no signs of true paralysis.

#### VI. DEFORMITIES - NO MARKED SYMPTOMS OF RICKETS

##### OBSERVED BEFORE TWO YEARS.

J. H. B., aged 2 years, brought for advice on account of weak ankles and a waddling gait. He was fed at the breast until 15 months of age. He had only one tooth at a year old, walked at 11 months, and talked at 15 months. On inspection, in addition to weak and splaying ankles, he had knock-knee, bow-legs, square rickety head, pot-belly, indigestion, and a bad appetite. He was kept on a strict diet until the digestive tract was in order, when the appetite soon returned, and he was able to take plenty of food with cream and tonics. He was kept off his feet, and splints were applied to fix the knee-joints and correct the knock-knee. He is now a strong and vigorous child of 3 years.

#### VII. RICKETS - CATARRHAL SYMPTOMS FOLLOWED BY CONVULSIONS AND DEFORMITIES.

F. D., aged 2 years, artificially reared by ignorant parents who ought to have known better. The child was chiefly fed on sopped bread, and first seen, about the age of one month, for a severe attack of bronchitis. At 3 months, it had vomiting and diarrhoea; at 12 months, convulsions often repeated; at 18 months, curvature of both femora and tibiae; and at 2 years and 2 months, an attack of broncho-pneumonia from which it died.

#### VIII. RICKETS IN A BREAST-FED INFANT, PROBABLY CAUSED BY GIVING STARCHY FOOD AS WELL.

J. B., aged 1 year. The mother is pale and anaemic, and has had three children in quick succession. The father, a postman but formerly a private soldier, does not now look well and strong. One other child is rachitic. The child was kept at the breast until nearly 12 months old. It was given rusks and bread at 5 months, but this was stopped when the child was brought for advice, breast-feeding being the sole form of nourishment allowed. The child has persistent colds, and bronchial catarrh alternating with attacks of diarrhoea. It is very anaemic, sweats about the head, and is restless at night. The head is box-shaped, and there is bowing of the right tibia. It can sit up fairly well, but there is an inclination to curvature of the spine. So far, only one tooth has been cut. Considerable improvement has taken place since the child was weaned and put on appropriate treatment.

IX. CASE OF RICKETS TREATED AS ONE OF WORMS.

J. W. D., aged  $2\frac{3}{4}$  years. For the last six months or more, with a variety of powders, has been treated for worms; but there has been no improvement, nor any sign of worms in the stools. The mother has five children, and this is the fourth. The child was at the breast for 7 weeks, then fed on Frame Food and milk, and occasionally Bovril. She only remembered that the boy was very slow in teething, and also backward in walking; he is still easily knocked over, and appears to be very unsteady on his legs. He began to walk at 16 months. When a baby, the child was never let out of the house until 7 months old, and for the reason that he was always catching cold. He has always suffered from a weak digestion, and usually has diarrhoea with frequent slimy stools. There is always restlessness at night. The child has the typical appearance of rickets: the large square head, Parrot's nodes, enlarged epiphyses, rickety rosary, funnel-chest, Harrison's groove, protuberant abdomen, and bow-legs. The tongue has an irregular (geographical) coating of fur, but there are no symptoms suggestive of the presence of worms. Nowadays, his food is the same as that of the rest of the family, and he is said to have a greedy and capricious appetite. Under suitable treatment and a strict dietary, the diarrhoea ceased, the abdomen became less prominent, and the child slept in a normal way. He is now on anti-rachitic remedies, and his general health shows signs of improvement.

# D I A G N O S I S.

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## GENERAL DIAGNOSIS.

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The diagnosis of a fully-developed case of rickets, - with its characteristic symptoms, together with the deformities of the osseous system, and the general disturbance of the bone-making function, - is a matter of no serious difficulty. The well-marked deformities of the head, thorax, and extremities, the thickening of the epiphyses, the protuberant abdomen, coupled with the retardation of development, - as shown by late dentition and the delay in talking and walking, - the tendency to catarrhs of the mucous membrane of the alimentary and respiratory tracts, the nervous irritability and instability, - as evidenced by sweating about the head and restlessness at night, - in toto constitute a clinical picture that is easily recognisable as produced only by rachitic disease. But, in the early stages of rickets in its attenuated forms, or if only one limb or one system of the body is attacked, the diagnosis may be difficult or impossible. It has previously been stated that, during the early months of life, the only symptoms may be constipation and anaemia, and, if these symptoms are present and persistent while no other cause can be discovered to account for their presence, the case should be regarded as probably an early form of rickets. In like manner, if the mucous tracts concerned with respiration and digestion are continually at fault the same disease should again be suspected. If a child is perpetually suffering from colds, mild attacks of bronchial catarrh or broncho-pneumonia, constitutional and not local trouble is present, and if, in the digestive tract, disorders - such as dyspepsia, gastric catarrh, gastro-enteritis, or even abnormal appetite - recur repeatedly, the diet and general hygiene of the child should be revised, and a provisional diagnosis made that the case is one of rickets.

Even when ill-defined nervous symptoms alone are present, the real diagnosis may prove to be rickets; restlessness at night, sweating of the head, kicking off the bedclothes, or night-terrors should awaken a suspicion that the true cause of the child's ailment and unrest is the onset of that affection. Convulsions, occurring after six months of age in an apparently healthy child, should cause the medical attendant to search carefully for further evidence of the presence of rickets. The early symptoms are slight, and if observed singly or detached from the graver signs of rickets, are scarcely by themselves sufficient to draw attention to the real nature of the disease.

Holt (Diseases of Children, p. 267) alludes to the difficulty in the diagnosis of rickets in the early stages, and thus sums up the question: "The most important symptoms for diagnosis are sweating of the head, craniotabes, great restlessness at night, delayed dentition, and enlarged fontanelle. All of these separately may



mean something else, but collectively they can mean nothing but rickets."

If it is clearly kept in view that rickets is a constitutional disease, with a slow and insidious onset, and not merely an affection confined to the osseous system, the diagnosis will be made in its earlier stages, and the disease arrested before permanent deformation or dwarfing of the body occur.

### **DIFFERENTIAL DIAGNOSIS.**

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#### DIGESTIVE TROUBLES.

In early life, an infant frequently suffers from gastric disorders due to improper feeding. It is very often impossible to discover any sign of rickets; but the child should be carefully watched, and the parents warned that persistent improper or excessive feeding may produce malnutrition, which will inevitably finally merge into rickets. All interested in the welfare of the child must not remain satisfied because it is fat and gaining weight; if its tissues are flabby, and the teeth are not being cut at regular intervals, or if standing and walking are delayed, then rickets is certainly present, and, when not arrested, the disease will slowly progress towards the stage of deformation.

#### MARASMUS.

More difficult of diagnosis are cases showing signs of malnutrition; and rickets may be confounded with atrophy, marasmus, syphilitic cachexia, and the tuberculous diathesis. If, during the progress of rickets, there has been prolonged and acute gastro-enteritis, the infant may be much wasted, and, unless it is possible to detect enlargement of the epiphyses, beading of the ribs or commencing deformities, the diagnosis of the disease, for a time at least, must remain uncertain. In marasmus, a healthy child begins to show progressive loss of weight, and gradually wastes away. The subcutaneous fat disappears, the skin is dry and inelastic, and the face is small and wizened like a very old man. The rectal temperature is subnormal, the bowels are irregular, the stomach dilated, the appetite voracious, but there is starvation of the tissues. The nervous symptoms are twitching of the face, rolling of the eyeballs, picking at the bedclothes, and convulsions. Sweating, if present, is general all over the body, and is not confined, as in rickets, to the head and neck. In the final stages, there may be oedema of the face and limbs. It is important, if possible, to diagnose the condition from rickets: for the marasmic infant is only able to digest small quantities of fat, and, contrary to the rachitic, requires a low fat diet with a gradual, but slow, increase in the percentage of the proteid - especially the soluble albumins.

#### SYPHILITIC CACHEXIA.

In syphilitic cachexia search must be made for the stigmata of the disease: chronic snuffles, desquamation of the skin, cicatrices or mucous patches should prevent doubt arising concerning the true condition of the child. Syphilitic affections usually affect the infant in the early months of life - generally some time before

rachitis has made its appearance.

### TUBERCULOSIS.

Tuberculosis may appear in infancy. In 1045 autopsies at the Infant Hospital of New York, Emmett Holt found tuberculosis in 119 cases - an average of 14 per cent. Formerly, the disease was supposed to be rare in infancy, but Holt found 57 cases in the first year, and 39 in the second, out of a total of 143 cases.

The presence of enlarged glands in the cervical region, or under the manubrium sterni, coupled with bronchitis or broncho-pneumonia in a rickety child, may cause an error in diagnosis. It is almost impossible to diagnose abdominal tuberculosis from rachitis.

During the period of first dentition, rickets often passes unnoticed, and the symptoms of diarrhoea, gastric catarrh, nocturnal restlessness, head-banging, and convulsions are attributed to "teething". Unless all other can be excluded, none of these symptoms (unless head-banging be excepted) should be attributed to teething alone. If dentition be regarded as a normal process, any great disturbance of the health should cause inquiry to be made into the state of the digestive organs, and these should be regulated, and the case carefully watched, before ascribing any infantile ailment to the irritation of dentition.

### WORMS.

The digestive disturbance, the mucous catarrh, the geographical tongue, and the nervous unrest of rickets may occasion a provisional diagnosis of worms, but, unless more definite evidence of the presence of the parasites can be obtained, this diagnosis ought seldom to be seriously entertained.

### SCURVY.

Infantile scurvy makes its appearance about the same age as rickets, between the sixth and the fifteenth months, and may lead to confusion in diagnosis. In the early stages of scorbutus, when there is malaise, fretfulness, anaemia, and malnutrition, it may be impossible to distinguish the disease from rickets; but pain in the limbs usually appears early, and draws attention to the true nature of the complaint. The tenderness is chiefly in the shafts of the bones, the limbs lie motionless, and there is dread of movement or of being touched. The child cries when it is handled. In the later stages, the haemorrhagic symptoms simplify the diagnosis. The purple haemorrhagic gums, - especially noticeable round a newly-cut tooth, - the subperiosteal haemorrhages, the puffiness and ecchymosis of the eyelids, with occasional proptosis of the eyes, and the haematuria are distinctive symptoms which are never seen in rickets. The prompt recovery of the child under anti-scorbutic treatment, which in no way influences rickets, effectually settles the diagnosis of the disease. If scurvy and rickets co-exist, the lesions of the latter disease will remain unaffected under this treatment, and, therefore, as the scorbutus is cured, later on stand out more prominently.

### SYPHILIS.

The diagnosis between rickets and syphilis should present no great difficulties; but, if the case shows marked craniotabes, Parrot's nodes, and enlarged spleen, combined with typical symptoms of rickets, the suspicion

that both syphilis and rickets are present is warranted.

In the later months of infancy, rachitis is more apparent, and the symptoms of syphilis gradually disappear. After six months of life, the detection of syphilis becomes more difficult. The lesions of congenital syphilis appear much earlier than those of rickets, and the later bony changes are not confined to the epiphyseal junctions as in rachitis.

According to George Carpenter (Syphilis of Children, p. 73), by twelve months of age the syphilitic wave is at its height, and may continue feebly for another year; on the other hand, at six months of age the rickety wave is just beginning to make headway, and between the first and second years should attain its maximum.

Congenital syphilis usually appears about the third week, when the nails may be shed, and a coppery rash appear upon the skin. The teeth often appear before the normal period of dentition, but are prone to early decay - this being specially marked in the case of the upper incisors. There may be also snuffles, syphiloderma, and subcutaneous gummata. Epiphysitis of syphilitic origin usually occurs at an earlier age than that of rickets, and, if present only in one joint, is seldom due to the latter affection. Beading of the ribs is seen in both rickets and syphilis. An enlarged spleen and cranio-tabes in the case of a rickety child should always arouse a suspicion that syphilis is present also.

#### NERVOUS DISEASES.

The inability of the rickety child to stand or walk may result in a diagnosis being made of some nervous disease. The muscular debility of rachitis may require to be differentiated from infantile or diphtheritic paralysis, or from paresis due to syphilis (pseudo-paralysis), or caused by injuries received at birth (obstetrical paralysis).

##### Infantile Paralysis.

Infantile paralysis has a prodromal period of about a week, with marked fever and malaise; the paralysis is nearly always unilateral, and is limited to one limb or group of muscles. The muscles are flabby, cold, and wasted; the electrical reactions are altered, there being little response to faradism, and, as a rule, the reaction of degeneration is present in the atrophied muscles.

##### Diphtheritic Paralysis.

Diphtheritic paralysis may occur, in cases of a mild type, when the throat symptoms have been overlooked, or were too slight to attract attention. The larynx and soft palate are frequently affected, - so that the child's voice is hoarse and nasal, its cough toneless like that of a cow, and there may be regurgitation of food through the nostrils. Squint is a frequent symptom. The patellar reflex is nearly always lost, and occurs independently of the position of the nerve lesions.

In rickets the muscles are weak and flabby, but there is not true paralysis. The child can use his limbs freely, but refuses to stand or walk - this disinclination and debility being the result of a malnutrition of the muscular system. The reflexes remain unaltered, and the electrical reactions are normal. There may be some



weakness of the nervous system, even when the muscles are firm and powerful - producing a rachitic pseudo-paralysis, which condition may require the application of electricity before a cure can be effected.

#### Irritative Neuroses.

The frequent association of rickets with head-banging, head-nodding, convulsions, and general restlessness at night should always be kept in mind, although a diagnosis cannot always be positively made from the reflex irritations of the first dentition. Tetany and laryncismus stridulus almost invariably can be diagnosed as disorders proceeding from a rickety state, and their treatment should be carried out on lines adapted to the cure of this disease. With the appearance of the characteristic box-shaped head, the contracted thorax, and the curvatures of the limbs, the nature of the affection is very evident, and rickets is then seldom liable to be mistaken for any other disease.

#### Hydrocephalus.

In mild cases it is difficult to distinguish hydrocephalus and rachitis. The square head of rickets ought not to be confounded with that of hydrocephalus, which is globular; and there is ~~is~~ <sup>greater</sup> ~~widening~~ of the sutures and fontanelles. The mental deficiency in hydrocephalus is usually more pronounced than in rickets. In later stages, the forehead of hydrocephalus is very over-hanging, and there is great increase in the breadth of the cranium. In rickets the enlargement ~~is~~ largely due to the thickened bosses of the parietal and frontal bones, and measurements show that the head is not much increased in size. If doubt should arise, the progressive enlargement of the head, month by month, will finally settle the diagnosis. The presence also of rickety changes in other bones of the body helps to distinguish the two conditions.

#### SYPHILITIC CRANIOTABES.

It may be impossible to distinguish the craniotabes of rickets from that of syphilis: each case will be required to be judged by the presence or absence of other symptoms, and further aid may be obtained from the family history.

#### SPINAL CARIES.

The differential diagnosis between the curvature of the spine due to rachitis and the caries of Pott's disease has already been referred to in these pages. The absence of any sharp angular projection, and the disappearance of the curve upon extension, will demonstrate the presence or absence of organic disease of the spinal column, or destruction of the bodies of the vertebrae. Both conditions, however, may be present, and it may be necessary to examine the spine very carefully from time to time during the progress of the disease before making the final diagnosis.

According to Holt, marked lateral curvature, under three years of age, is usually a rachitic condition.

#### PSEUDOHYPERTROPHIC PARALYSIS.

The presence of very marked lordosis in a child may render it necessary to eliminate the possibility of pseudohypertrophic paralysis; but the great development of the calf and deltoid muscles, the drawing-up of the

heels, and the peculiar manner adopted for assuming the erect posture should serve to prevent this error. Curvature of the spine or knock-knee may be the sole evidence of the presence of rachitic disease.

#### CONGENITAL DISLOCATION OF THE HIP.

In congenital dislocation of the hip, the child is usually knock-kneed, and walks with the knees turned in, - so that the condition may simulate rachitis. If the head of the femur is lying outside the acetabulum in the iliac fossa, and the great trochanter situated at different or abnormal levels, the case is one of congenital dislocation and not rickets. In cases of doubt, careful measurements should be taken of the limbs, and a skiagram will demonstrate the true position of the bones. In cases of congenital dislocation, the trochanter can usually be drawn up and down without pain - a manipulation which would be quite impossible when dealing with rickety deformity of the femur.

#### OSTEOMYELITIS AND SYPHILITIC OSTEITIS.

If rickets is present only in a single bone, it may be difficult to correctly diagnose the condition from osteomyelitis, or from the osteitis of syphilis.

Acute septic osteomyelitis usually begins at the end of the diaphysis, but the rise of temperature, and the appearance of purulent effusion make the true nature of the disease soon evident. The thickening of the limb and the general enlargement of the bone in chronic osteomyelitis may suggest rachitis or scurvy, but the diagnosis will probably be arrived at by considering also the pain, tenderness, and the constitutional disturbance.

If the disease is limited to the tibia, it may be considered a lesion of congenital syphilis. The syphilitic tibia of Lannelongue is not curved, but swollen, nodulated, and deformed of gummata or deposits of bone; in rickets there is actual curvature of the bone, usually most noticeable in its lower third, and its shape has been likened to that of a cavalry sabre. If greenstick fractures have occurred, there may be some roughness or irregularity of the surface of the bone. The thickening of the lower epiphyses, and the probable presence of slight rachitic symptoms, - such as beading of the ribs, - together with the history of the case, should prevent confusion between the two diseases.

#### CRETINISM, MONGOLISM, AND ACHONDROPLASIA.

Though in marked cases no difficulty should arise, yet, occasionally rickets may be confounded with cretinism, mongolism, and achondroplasia.

A prominent distended abdomen, often with umbilical hernia, is common to the cretin, the mongol, and the rickety child; the dwarfism of achondroplasia may possibly simulate the stunted growth of rickets, but the marked disproportion of the head, trunk, and extremities should suffice to differentiate these two diseases.

The depressed bridge of the nose, the open mouth, the peculiar slant of the eyelids, the general expression, and feeble mental development ought to mark out the cretin or the mongol in sharp distinction from the rickety child.

For the sake of convenient comparison, the main

features of these four diseases are tabulated as follows:

### Rickets.

This disease is rarely congenital, and is usually noticed after the sixth month of life.

All parts of the body are uniformly affected, though there may be special shortening of the lower extremities, and permanent dwarfism in later life.

The child stands and walks late, and there is debility of the muscular system.

Anaemia is a constant and early symptom: in the aggravated forms of rachitis, the acute splenic anaemia of v. Jaksch may be present.

In ordinary cases, the temperature is normal: if complications occur, there is pyrexia, and, in the later stages, it is often subnormal.

The skin is not always affected: there may be some deposition of fat, or eruptions due to excessive sweating or gastric disturbances.

The shape of the head is square and box-like, with prominent Parrot's bosses, and sometimes spots of craniotabes and a bald patch on the occiput. The anterior fontanelle is widely open, and is late in closing. The face appears small, and ill-developed in comparison to the head. Dentition is delayed.

The chest is narrow, there is beading of the ribs, Harrison's groove, and prominent sternum with a central depression.

There may be curvature of the spine - usually kyphosis with a long and rounded curve.

The epiphyses are thickened, the extremities bowed and stunted, and there may be prominent tubercles on the long bones.

The hand is normal in size, but may show Koplik's bowing of the fingers, or the heading off Neurath, as well as the thickening of the ungual phalanges causing the resemblance to a ninepin.

There is profuse sweating of the head and neck at night, restlessness, and other nervous phenomena.

Constipation may be present, but is not a regular symptom.

There is considerable retardation of mental development. The child is late in talking, but may be intelligent in later life.

Unless deformities are permanent, it may be impossible to detect the disease in the adult.

### Achondroplasia.

This affection is always congenital - an important fact to bear in mind.

The extremities are exclusively affected by dwarfism: the shortness of the arms and legs is particularly striking in comparison with the trunk, which is of normal size.

There may be delay in walking, but the muscular development is good.

There is no marked anaemia.

The temperature usually remains normal.

The skin is unaffected, though there may be a redundancy of tissue, causing folds about the legs.

The head is large, and, owing to the shortness of the limbs, is a striking characteristic. The shape of



the head resembles that of hydrocephalus, being globular, with marked frontal and parietal bosses. There is delay in the closure of the anterior fontanelle. The face is not relatively small, and the bridge of the nose is depressed. The nostrils are gaping, and the end of the nose is bulbous, and thus differs from that of the cretin and the mongol. The features of the face are large, and dentition is normal.

The chest is well formed and normal in dimensions; there may be some beading of the ribs, due to periosteal overgrowth, or forward displacement of the cartilage or bone, occasioned by invasion of the periosteum.

The trunk is normal, but of a size more suited to an individual of larger stature.

There is marked lordosis of the spine in the lumbar region, and a tilting upwards and backwards of the pelvis.

The extremities - especially the lower ones - are shorter than normal: the upper limbs appear to have their attachments at a level more posterior than usual, and seem to hang back considerably. There is a tendency to hold the arms away from the trunk.

The epiphyseal cartilages are not thickened.

The hand is small, square, and reduced in all dimensions; the fingers are almost of equal length; the last phalanges of the middle and index finger diverge, producing the characteristic "main en trident" deformity.

In achondroplasia mental impairment may not be very marked, but the patients are often childish, and the stability of their nervous system is easily unbalanced.

James Taylor (Nervous Diseases of Children, p. 343) considers that their usual standard of intelligence is low, and justifies the description of most cases as weakminded, though other writers describe the achondroplastic as quickwitted.

#### Sporadic Cretinism.

Cretinism may be an endemic or a sporadic disease: if endemic, the thyroid is usually enlarged, but, in the sporadic form of the affection, it is small or absent. The condition is often congenital.

The extremities are more affected than the other parts of the body.

Walking is late, and coördination poor.

There is no definite paralysis, but very little muscular power.

Anaemia is present, usually of a chlorotic type (yellowish-green), with discoloration of the skin, and diminution in the percentage of haemoglobin.

The skin shows the characteristic infiltration of myxoedema: it is swollen, dry, and scaly, and there are often fatty pads in the supraclavicular regions. As in achondroplasia, there may be a redundancy of the tissues about the legs, causing folds in the skin, which seems too large for the bones within.

The head is small, and the hair stunted and scanty - the scalp often having a dirty appearance. The fontanelle is late in closing. The bridge of the nose is depressed, the forehead is low, the eyebrows scanty, the palpebral aperture is narrow and immobile, the lips are thick, and the jaw is prognathous. The mouth is usually open, and

from it protrudes a fleshy tongue, which decreases in size under thyroid medication.

The voice has a peculiar nasal tone: it is harsh and croaking.

In cretinism the teeth appear very late, and are liable to early decay. The thyroid gland is small and absent.

The extremities are shorter than normal, and there may be slight curvature of the bones.

There is frequently kyphosis of the spine, together with muscular weakness and laxity of the joints.

The hand is flat and spade-like: it is nearly always cold and blue; the fingers are short and stumpy, and the skin is puffy and oedematous.

The cretin is very sensitive to cold: the temperature is invariably subnormal, but it reacts readily to thyroid medication.

The skin is harsh and dry, and, unlike the rachitic, the cretin never sweats.

Usually there is obstinate constipation, dating from birth, and due to infiltration of the coats of the intestine.

The patient resists all forms of treatment, but is cured by the administration of thyroid-extract.

Cretins are often of infantile physical proportions.

They differ in their mental qualities - sometimes being placid, impassive, and good-natured, but more often restless, destructive, and vicious. As a rule, the mental state is one of considerable backwardness. Unless under the specific treatment with thyroid-extract, the cretin remains little more than an idiot, and, even under the most favourable conditions, hardly ever reaches a normal standard of intelligence.

In cases of doubt, the marked and rapid improvement under the specific treatment aforesaid should help to confirm a diagnosis of cretinism.

#### Mongolism.

Mongolism is always an congenital affection.

The infants are small at birth, and growth is usually slow.

The child is generally smiling, grimacing, and good-tempered.

Walking is delayed, and, if the case remains untreated, the limbs lack power of coördination.

Anaemia is present, the effect of which is heightened by bright-red patches on the cheeks, which have the appearance of being rouged. The percentage of haemoglobin is diminished.

The temperature is subnormal, but not so marked or so persistent as in cretinism.

There is no myxoedematous infiltration of the skin, and its condition is natural.

The head is brachycephalic, small, and short at the base; the antero-posterior and lateral diameters are almost equal. The occiput is flattened, and there is a hollowing at the temples. If the child attempts to smile, the peculiar wrinkling of the skin makes the expression more like a grimace. All the fontanelles and

the sutures remain open longer than normal. "The smiling face of the Mongolian idiot suggests the

possession of some secret source of joy, while the sad countenance of the cretin suggests the cherishing of a secret sorrow" (Sutherland). The bridge of the nose is depressed, and the aperture of the eyelids is a long, narrow and oblique slit as seen in the Chinaman. There may also be strabismus or nystagmus. The mouth is small, and is usually kept open; the tongue is large and protruding, as well as often fissured. The teeth appear late. The high-arched palate is a noticeable feature, the nasopharynx is small, and snoring is usual when the child is asleep.

The long bones are shorter than normal, and there is great laxity of all the joints, which are usually loose and mobile - owing to the laxity of the ligaments and hypertonia of the muscles.

The hand is small and tapered: the second phalanx is small, and there is a peculiar crooking-inwards of the last phalanx of the little finger.

Constipation is not a constant feature. There is some impairment of the mental powers; the child is lively, but imbecile or idiotic, and shows no improvement under thyroid treatment.

James Taylor (Nervous Diseases of Children) describes the condition as one of placid backwardness.

The child is quiet: it does not often cry, and it is unnaturally free from vice.

John Thomson and Archibald Garrod have both drawn attention to the frequent presence of congenital cardiac disease in these cases; and there may also be congenital club-foot or imperforate anus.

There is a great tendency to the deposition of fat about the period of puberty.

#### OSTEOGENESIS IMPERFECTA.

This disease requires careful differentiation from rickets. The principal points characterising osteogenesis imperfecta are that the disease is usually congenital in origin, the frequency of fractures, and the slight pressure or movement required to break the bones, as well as the softness of the latter, and failure of anti-rachitic and anti-syphilitic medicaments to bring about a cure.

#### DESIRABILITY OF EARLY DIAGNOSIS.

If the deformities of rickets and the permanent dwarfing of the child are to be prevented, the disease must be watched for in its earliest stages; and the association of trivial symptoms denoting little by themselves, but which, when grouped together, indicate rickets, should warrant a diagnosis of this disease; furthermore, an immediate attempt should be made to arrest its insidious progress by prompt and efficient treatment.

It is estimated that from 3 to 7 per cent. of female infants suffer from rachitis to a sufficient degree to affect the pelvic diameters.

The early diagnosis in the case of the female infant is of the utmost importance, because it may then be possible to arrest the disease, and so prevent the development of the osseous deformities of the and the later perils of parturition.



## P R O G N O S I S.

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Of itself, rickets is seldom, if ever, a fatal disease, but its complications and sequelae often lead to a fatal issue. It is an added danger to infant life, a period when existence is always rather precarious.

Largely a disease of civilisation, it is one of the great factors in the very considerable mortality during the first two years of life, and, although the name may not always appear on the certificate of death, a large proportion of the loss of infant lives can be traced to disorders of the gastro-intestinal and respiratory organs, which primarily can often be attributed to rickets. Nervous disorders claim a certain number of victims; and one of the principal causes of convulsions occurring after the first six months of life is rachitis: for, if the child's constitution has been undermined by the malnutrition of this disease, convulsive attacks are very liable to prove fatal.

The course and severity of the disease will determine the ultimate prognosis of a case of rickets. As a rule, the disease, slow in its onset, will run a **slow** and chronic course, which may extend over many years. In the rare cases of acute rickets, the disease flares up suddenly, and lasts only a few weeks. It may, however, produce so profound a cachexia that the child succumbs to its virulence from collapse and exhaustion.

A prompt recognition of the suspicious symptoms of early rickets is most desirable: for mild forms of the disease can then be arrested before the development of the severe lesions in the osseous system. But, if once the disease has got a firm hold, and has attacked the bones, or is complicated with visceral or respiratory disorders, the cure will be slow, and possibly not completed for many months. The greater the intensity and extent of the osseous affections, the greater the disturbance of the process of ossification; and the more profound the interference and undermining of the child's general health and nutrition, the slower will be the progress towards complete recovery. The prognosis is more hopeful, if the disease or deformity is limited to one limb than when the entire system is affected by rickets, though the intensity and the depth of the lesions are more reliable guides towards estimating the future results of the disease than its extent and distribution. If the osseous system is severely affected by rickets, it is an indication that the disease has been in progress for many months, and therefore no rapid recovery can be hoped for or anticipated; and, if the disease has advanced to a stage in which the deformities are permanent, it may even be necessary to seek aid from the surgeon before a cure can be completed.

Nevertheless, if rachitis only attacks the osseous system, and remains uncomplicated by affections of the lungs and viscera, the prognosis, so far as regards life,

is good. But, if catarrh of the lungs, stomach, or intestines is present, a graver view of the child's condition must be taken: for death may result from some intercurrent inflammatory disease.

Children suffering from laryngismus may die suddenly from prolonged spasm of the glottis.

Henry Ashby (Ency. Med.) has made several post-mortem examinations on children with well-marked rickets, who died suddenly from asphyxia, but who had never been heard to crow, or even known to have suffered from respiratory spasms.

The rickety child is always catching cold, and is very liable to attacks of bronchitis and bronchopneumonia, which are particularly dangerous - partly because the contracted chest interferes with the proper expansion of the lungs, and partly because thoracic and abdominal muscles are weak and unable to work efficiently, or capable of coping with the extra strain thrown upon them by the acceleration of the breathing, the coughing, and the efforts of the child to rid its bronchial tubes and pulmonary tissue of any accumulations of mucus. Even if death should not ensue, the imperfect expansion of the lungs, and the deficient oxygenation of the system may retard the proper growth and development of the child.

Infectious diseases are particularly dangerous to life, if contracted by a child already the subject of rickets; and a great proportion of the deaths in early life from scarlet fever and whooping-cough occur in cases where these affections have been engrafted on to a previous rachitic dyscrasia. These exanthemata usually appear in an acute form, and run a severe course in a rickety child. Whooping-cough throws an increased strain upon a narrow and contracted chest with little resiliency and but feeble power of recoil, with lungs imperfectly expanded, and liable to collapse or emphysema, - so that the child often dies from asphyxia, spasm, or sheer exhaustion.

Any prolonged disturbance of the gastro-intestinal tract is apt to lead to general malnutrition; and this condition, if present, must influence unfavourably the prognosis of rickets: for it adds considerably to the dangers affecting the life of the child. Even mild dyspepsias in rickets frequently run a prolonged course, and do not yield readily to ordinary treatment. As a rule, the gastro-intestinal complications are governed by the severity of the disease; if the case is one of mild rickets, the disturbances of digestion are slight, but, if the rachitis is severe, the various portions of the alimentary canal may be disordered by acute and dangerous catarrhs and inflammations. The evil results of rickets upon the digestion may be apparent for many years: for they do not always disappear with the cure of the disease. The child may be left with a feeble digestion, and a tendency to chronic catarrh of the stomach and bowels; it may suffer from mild hepatic disorders, gastric dilatation, or obstinate constipation. It is even asserted that many of the ptoses of the visceral organs, and the chronic digestive derangements of adult life, owe their origin to the profound disturbance of the entire system by rickets incurred during infancy.

The complications involving the nervous system add very considerably to the danger of rickets: for sudden death may occur during convulsions or tetany, while the risk of asphyxia, from the spasm of laryngismus, has been already referred to. The damage to the nervous system may remain permanent.

Gowers has stated that 10 per cent. of all cases of epilepsy have previously suffered from rickets, while Coutts assesses it at 17 per cent.

When rickets is associated with hydrocephalus, the prognosis is bad. There is a great tendency for the rickety child to grow up neurotic, excitable, and wanting in the power of concentration or self-control. It bears badly the strain and competition of school-life, and suffers from headaches, fitful sleep, somnambulism, or night-terrors. There may even be permanent disablement or deficiency of the mental powers.

Rickets spontaneously progresses towards recovery, but, if left untreated, the deformities remain permanent, and incapacitate, or partly disable, from useful work in after life. The child may grow up stunted, or even a dwarf; and, if it has well-marked knock-knee or flat-foot, it is placed at a great disadvantage when applying for appointments with other competitors.

In the case of a woman, the risks of pregnancy are much increased, and the narrow contracted pelvis may be a source of danger both to the mother and the child unborn.

After rickets has disappeared from the system for years, and its effects are no longer visible, the possibility of the occurrence of late rickets must be kept in view; and any symptoms of muscular fatigue, produced by slight exertion, or nervous exhaustion in children, who were formerly the subjects of infantile rickets, ought to be treated as possible prodromata of the recurrence of this disease - more especially of these disturbances become evident with the onset of puberty.



# T R E A T M E N T.

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## GENERAL CONSIDERATIONS.

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The treatment of rickets does not involve only the cure of the disease, but opens up deep and far-reaching problems of social and national importance. If there is to be thorough treatment and any real eradication of the disease, the causes at work, - resulting in the heavy infantile mortality and the effects of ignorance, bad feeding, overindulgence, and poverty, - must also receive due consideration.

In the twentieth century, with its notable advances in science and medicine appearing every year, it does not seem creditable that, in every out-patient clinic of the children's hospitals throughout Europe, a percentage of 50 or more cases of rickets can generally be found.

The excessive infant mortality has attracted considerable attention, and the whole question is being carefully studied, in the hope that means may be found to remedy the social evil; but it is not always remembered (and the point requires to be pressed home) that, though many infants perish in the early months of life, many more struggle on ill-fed and badly nourished, - so that they grow up eventually with the seeds of disease ready to germinate in later life. They may escape the perils of malnutrition or acute disorders of the alimentary and respiratory tracts, but their constitutions have been debilitated by rachitic disease, and they grow up stunted, deformed, and crippled both in mind and body. The men have their wage-earning capacity diminished, and the women have extra dangers added to the perils of maternity.

Throughout the land, the deteriorating influence of alcohol is being emphasized; it is time that the far-reaching results of rickets on the future of the race should ~~also~~<sup>also</sup> be demonstrated - in the home, on the platform, and by the press. If necessary, efficient legislation must be adopted to safeguard the infant during its early life, and more stringent efforts made to control the sale of patent foods, which are almost as deadly as alcohol or other poisons to the growing child.

The dangers arising from defective drainage in a home, and the evils of dirt and insanitary and unhygienic hygienic conditions are attended to with considerable assiduity by municipalities: nevertheless, an infant is allowed to be slowly and surely poisoned by improper food - a state of affairs as dangerous to its vitality and well-being as the chronic inhalation of sewer gas, or other noxious fumes or toxic products.

Another important step in the thorough eradication of rickets is the proper training of the parents, especially the mothers, in the proper way to nurture their children, - so that they can grow up strong and sturdy, and become valuable assets of the Empire, and, as far as possible, avoid their rearing, - with

infinite pains, trouble, and expense, - a race of delicate infants, crippled children, or neurotic, feeble-minded, and degenerate adults.

It may sound somewhat paradoxical to suggest that the real treatment of the disease is to be found in a careful attention of the pregnant woman and her unborn child. It might seem better to include this under the heading of Prophylaxis, but we are not aware how far rickets is due to heredity, diet, or environment; and, therefore, the actual treatment of the disease, assuming that it may even develop in the foetus in utero, should be directed to the mother, as well as to the child after birth, before the appearance of the later and obvious stages of the rachitic disease.

It is almost impossible to dissociate rickets from the various factors at work causing the heavy annual infant mortality; and it is surely reasonable to speculate that, if some of the various causes which are responsible for this terrible death-roll are eliminated, at the same time will gradually disappear: for, in process of time, a hardier race of children will be reared and nurtured by intelligent parents, and placed amidst better conditions of hygiene and environment.

If treatment is carried out on these lines, there will be little need for drugs; and the scientific worker will cease to search for a specific remedy for the disease - in phosphorus, cod-liver oil, thyroid, and other extracts. With better education, good food, sunlight, and fresh air, the disease must die out and disappear, and the hardy races of the future should be immune to any recrudescence.

The rational prophylaxis and treatment of rickets is summed up as the care of the mother during pregnancy and lactation, and of the child during the first two years of life, during which time it is carefully watched in its rapid growth and development, and educated to adopt normal and regular habits of living, and thus prepare for the stern struggle for existence. Many cry "Back to the land!" will solve the problem of the unemployed; it might also help the rational treatment of the rickety infant to remove it from the crowded towns, but "Back to the breast!" should be dinned into every mother's ear; and every woman should be taught to regard recourse to artificial feeding, except under exceptional circumstances, as a stigma and a disgrace to our vaunted civilisation.

In this thesis, it is proposed to depart in some measure from the routine methods of treatment adopted by the text-books in general, and to discuss fully the best methods to be adopted to safeguard the mother during pregnancy, and the care of the child during the first two years - paying particular attention to the methods that can be adopted for feeding delicate and rachitic infants. From time to time, it will be impossible not to wander away somewhat from the subject of rickets; nevertheless, it is hoped that none of the matter may seem irrelevant, but bear, directly or indirectly, upon the prevention or treatment of the all-important rachitic dyscrasia.

# THE PARENTS.

## I. THE FATHER.

The influence of the father upon his offspring may be very considerable; but, in his endeavours to safeguard an unborn child from rickets, the medical man can seldom influence the paternal source, or afford much help or guidance, unless under exceptional circumstances.

If, however, one or more of the children show signs of rickets, it might be advisable to inquire into the family history of both parents, in order to ascertain if they had suffered from rickets in their infancy, and also to point out to them the necessity for special precautions in the future, because the later members of a family are more prone to this disease than those who were previously born. It is important to instil into the mind of the father the importance of parental responsibility: for it is impossible that the wife can be an efficient mother, and successfully feed her infant at the breast, if she must also be the bread-winner of the family and its main support. Many an infant is deprived of its natural food, or only receives its meals at irregular intervals, because the mother is obliged to slave all day as a charwoman, or, by hawking produce from door to door, in order to keep the home together, owing to the dissolute habits of the husband.

Poverty may be productive of much evil, but indiscriminate philanthropy may intensify what it endeavours to allay, or bring into existence other evils with far-reaching and immoral results.

Therefore, though little can be done towards the health of the father in its bearing on his future child, means should be taken, at school and in after-life, to educate him in the responsibilities of paternity; and, as far as possible, he should be taught to fight his own battles, and bear his own domestic burdens, and not encouraged too much to rely upon private philanthropy, municipal or district rates, or aid from various statutory enactments.

Leo Strachey (Manufacture of Paupers) points out that the real danger in the ~~manufacture~~ of paupers is not the waste of resources, but the unmaking of men.

The woman's true place is at home attending to the children, and she should not be allowed to return to work, especially in factories and workshops, if it interferes with the proper nursing of her child. If she is away all day, it is impossible to keep her house bright and cheerful, or her family united; and the husband, through lack of comfort, drifts to the genial warmth of the tavern for rest and companionship.

In these days, when the unemployed are crying out for work, substitutes for married women can surely be found without difficulty. The tendency of the present age is to rely, more and more, upon the wages earned by married women for the support of the home: this in time must affect the moral fibre of the husband, who becomes a dependent, and injures the health of the growing infant or tiny children. If philanthropy endeavours to rectify this unnatural state of affairs, by taking the



burden from the parents, and supports their children by means of free breakfasts and the like, it goes far to destroy the virtues of home life: for it causes the parents to evade their responsibilities, and, as years roll on, these children, grown to adult life, will cast the burden of their families also upon the State. The child is a unit in the family, and anything that tends to break up home life, with its joys and troubles, produces men and women lacking self-reliance and moral courage. Nothing therefore should be done to take away from men and women the qualities of independence and responsibility, or to lessen in the smallest degree the value of domesticity and family ties.

Questions of economics are beyond the scope of this thesis, except to show how these evils, tending to destroy the home, must infuriously affect the early nutrition of the infant, prevent breast-feeding, and pave the way for such a disease as rickets. The solution of these problems would help to decrease the infant mortality and the spread of rickets.

The cause of this disease cannot so much be traced to poverty as to ignorance, neglect, and overindulgence in improper food: the remedy lies in the better instruction of women in the performance of maternal duties, and the due enforcement of the law against paternal neglect.

Most men have a natural affection for their offspring, and this should be encouraged by developing their self-respect, as well as the sense of responsibility due to their family. Domesticity should be encouraged; and this can only be done effectively by increasing the wages of the father, by preventing as far as possible the labouring of married women, and by improving and brightening to the utmost the conditions of life at home.

George Gissing, in the pages of the "Nether World", describes, in a vivid manner, the character and condition of the lower classes: it is easy to imagine that the children of such a parental stock must be physically and morally unhealthy, and, living in an unwholesome environment, fall easy victims to diseases of malnutrition and rickets.

The advantages gained to posterity by better and airier houses, good lighting and ventilation, efficient drainage, parks, and open spaces, are largely destroyed, if the infant is deprived of its mother's milk, is brought up on the bottle or some other procedure of artificial feeding, and is further surrounded by added dangers through being deprived of a mother's constant care.

Deficiency of maternal milk, according to v. Bunge of Bale, is often due to the imbibing of alcohol by the parents. His statistics, drawn from all parts of Europe, show that women with an insufficient milk-supply are usually the daughters of alcoholics, and, if two generations have been alcoholic, the third generation will be unable to nurse their own children. Bunge also found that, when the mother was able to nurse her offspring, the daughter was lacking in this important function; in four-fifths of his cases, this inherited abnormality was due to immoderate use of alcohol on the part of the father. He also makes the important statement that, when the father is a drunkard, the daughter

loses the power of suckling her child, and, moreover, this power is lost for coming generations.

The father, therefore, must not altogether be regarded as a negligible factor in the prophylaxis and treatment of rickets. The bearing he has on the prevention of the disease is, indeed, only, in most cases, indirect: for his duty is to enable the mother to suckle her child, and thus prevent the evils that arise from artificial substitutes. But, if he can aid in this direction, the paternal member of each family strengthens the weapons at hand to fight against the spread of this ubiquitous disease, and benefits his family and the future generations.

## II. THE MOTHER.

### (a) HER EARLY TRAINING AT SCHOOL.

At the present day, even the children of the poor receive a good education, though it may not always be best adapted for their future wants, when they are plunged into the struggle of life and become mothers. The plastic mind of youth ought to receive impressions that could be stored up, and so prove of value and use in adult life. The elementary facts of cleanliness, cookery, and housewifery should replace to a great extent the facts of geography and history, or even the elements of music which sometimes give more annoyance than pleasure to listeners.

The writer does not approve of any attempt being made to teach children, by elaborate courses of physiology and domestic hygiene, though it is possible that they might benefit a few; for the bulk of information thus learnt is forgotten, - so that, in later life, when it is of value, the woman cannot reap the benefit of these early studies. The better plan would be to give frequent demonstrations on practical matters connected with the home, and to train children to use their eyes and their hands in the matters of housewifery. Most little girls **love** a baby, and lessons in the proper management of an infant could be made a pleasure and not a toil, whereas they would soon tire of listening to a lecture on a similar subject. The doll should be used far more than at present is customary in the education of the child. **With** a doll, children play at being grown-up; and it would be just as simple to teach them how to play this game properly - how to nurse and dress it - as to leave them to their own devices. They would thus become better **women** and mothers through the games of their childhood.

In Japan all the small children are trained to carry the baby on their backs, and the younger members of the family are accustomed to the nursing rôle they will have to play, by strapping on their backs a doll in the position that will in due course be occupied by a living baby.

In this simple fashion, a child could be trained with a doll to learn to handle a baby in an intelligent manner. She should also be taught how to wash an infant, to cut out patterns, and dress the doll with real properly-fitting clothes, and the uses of the various garments explained by the teacher. The older children

could have demonstrations on a living baby, and learn the routine of the nursery - special stress being laid on the value of scrupulous cleanliness and attention to small details.

It would be a simple matter to explain the value of milk as a food, and its modifications for the use of the infant, together with the proper methods of preparing whey, gruels, and the cookery of any articles required in the nursery. The general rules of cleanliness of the person, and all the utensils should be early insisted upon, and rigidly enforced in all cases, - so as to endeavour to form good and methodical habits.

The dangers of artificial feeding should be dinned into their ears; and they ought early to learn, as an axiom, that it is twice as dangerous to feed infants on condensed milk as on ~~fresh milk~~ cow's milk, and fifty times as dangerous on cow's milk, or one hundred times as dangerous to feed on condensed milk as on mother's milk.

Short lessons, frequently repeated, would prove of far greater value than routine courses of lectures comprising a far larger amount of information. Frequent repetition is necessary to enable the brain to store up the facts, and remember them in after-life.

The Manchester Education Committee have drawn up a course of six lectures on the feeding and tending of infants and young children; but the writer is inclined to do away with any lessons that are grouped together as a "course", or require to be defined collectively in a syllabus. Dr. Niven (Infantile Mortality Report, pp. 40-56) gives a very comprehensive syllabus of such lectures and demonstrations, which appears to the writer to be far too full and elaborate. A simpler course is that drawn up for the elementary schools of Liverpool by the Education Committee thereof, the substance of which is published as a useful little book by Blanche Tucker (Notes on the Care of Babies and Young Children, 1907), and it should be serviceable as a text-book for older girls and teachers.

Let the child have a few general facts constantly in its mind, and on these the proper education of the mothers of the future could be constructed; use the doll for demonstration, even in the infant schools, and more systematic instruction with the baby in the case of children over fifteen years of age! The older girls might possibly derive advantage by working at a crèche under a qualified instructress. Illustrations should be largely used, and there seems here a great opening for pictorial display by a magic lantern.

The influence of heredity might receive attention, and elementary facts could be taught in the schools, divested of all scientific language. It should be shown that vicious or indulgent habits of living are handed down from the parent, and visited upon the child. This moral training should be used to stimulate girls and boys to grow up useful citizens, and thus encourage true patriotism. They should learn, by biological examples, how the race is perpetuated, or slowly altered in the course of time, and how the effects of environment, the modifications of organs and limbs used for special



functions, or even the abuse of food and drugs, or manner of living, may alter types of animals or mankind for good or evil. The **process** of evolution could be simply illustrated by the various types of plants and animals.

After leaving school, many of these children must earn their livelihood in domestic service, and often the youngest and most inexperienced take situations as nursery maids. An unfortunate baby is only too frequently left in the charge of an ignorant and incompetent girl, and must necessarily suffer much at her hands. Many infantile disorders owe their origin to the nurse giving the baby food or sweets to keep it quiet.

The domestic servant is a source of worry and vexation in many households, but, if at school she has been trained in the elementary laws of hygiene and cooking and received a certificate testifying to her ability, many houses could be worked with greater efficiency and comfort. But, in only few instances should the mother be relieved of the responsibility of the superintendence of the nursery and her child, and she should always be a check on the conduct of the nurse-maid.

Nevertheless, the servant who takes a situation as a nurse, should be trained in the school to become such, and show some aptness for the position of trust she is to occupy and for which she receives wages. All nurses should be able to show that they have been trained in domestic hygiene and the care of the baby, and should hold certificates, which could be given for various grades of proficiency. In service, dated certificates of conduct - such as are issued to seamen and officers of ships at the end of a voyage - would check her conduct and character, and show if she had been continuously in employment, and prevent the forgery of eulogistic references. Better servants can only mean better wives and mothers; and, from the training received at school or in the homes of their employers, a more intelligent management of children will result, with a consequent diminution of diseases and sickness. Therefore, the education of the school-girl may indirectly help to prevent the appearance of rickets in many a home.

#### (b) DURING PREGNANCY.

The mother should early learn the responsibility of attending to her own health, on account of the influences it has upon her unborn child. Young women are often badly informed, or totally ignorant, of the most elementary facts connected with maternity, or the proper care of the child when it comes into the world. If she has been able to seek advice from a medical practitioner, she will probably derive some instruction, but more often she obtains it through her friends. It is at this stage of her life that tactful Inspectors, or kindly District Visitors, could afford much assistance. Mothers' meetings might be made more educational, and, instead of a book always being read aloud, some instruction, in a popular manner, might be given on various matters connected with maternal duties or the home, or the doctors of the district might be asked to give short talks on subjects of interest and utility, - such as the health of the mother during pregnancy, and the value of breast-feeding as compared with the artificial method, - enlivened, if possible, by lantern illustrations. It is doubtful whether poor women could be persuaded to attend any systematic

course of lectures; and the writer considers that they would learn more from facts conveyed to them in an informal and friendly manner.

A much more elaborate attempt at Health Talks has apparently been attempted by D. John Grimshaw, which is published under the title of "A Plea for the Child". These lectures may help to educate women of the better class, but our main endeavour must always be to infuse useful knowledge of motherhood among the poor, and in the simplest and most direct manner possible.

The food of the pregnant woman should receive some attention. Morbid cravings must be discouraged, and regarded as pathological, and only healthy food permitted during pregnancy. It must be explained that the food taken should be good and nutritious, owing to the great effect it has on the development of the unborn child. The use of spices or condiments in excess must be avoided; it must be pointed out that there is danger in the abuse of tea and coffee, as these are nerve-poisons. The vice of excessive tea-drinking is almost as prevalent amongst poor women as that of alcoholism: they should learn that both are poisons when used without moderation.

Infants born of alcoholic mothers are difficult to rear, or may even require a stimulant: a few words of caution may bear timely fruit; and a warning, that continual drugging with powders for headache or sleeplessness may have a detrimental influence upon the development of the foetus, may prevent the formation of bad habits by the mother while she is carrying the child.

The quality of the food is of more importance than the quantity to the pregnant woman; and intemperance in eating must be avoided. It seems probable that errors in diet, - especially excess of nitrogen, as evidenced by Chalmers Watson's experiments and case, - may react very powerfully for evil on the foetus, possibly by overstimulation, or interfere with the future development of the child after birth. An excess of carbohydrate food is unnecessary and harmful: for it only throws extra work on the kidneys of the pregnant woman, and does not benefit the foetus, which derives its sustenance mainly from a small amount of nitrogen. Women during pregnancy should be discouraged, therefore, from living on a perpetual diet of bread and butter, cakes, and tea. Poor people do not eat the food supplying the most energy; they take strong infusions of tea, with bread and butter, when they would do much better on porridge and milk.

Autointoxication of the mother by the food may affect the child, unless the placenta proves an efficient filter, and is able to prevent the passage of toxins. The mother has also to deal with the excretory products of the foetus, - so that it is very important that she should not have to get rid of a surplus of her own.

Ballantyne has suggested taking women into hospital for the later months of pregnancy; and, in certain cases, this would prove of the greatest value.

But, in normal pregnancies, the woman should learn to live an outdoor life. Good air, sunlight, regular exercise (short of fatigue), daily employment, and cheerful companionship help to quicken vital processes.

regularity of life promotes appetite and induces healthy sleep. The routine walk should be avoided, as being monotonous; and often the general interest of housework, which promotes bustle and activity, will be found more stimulating. The household surroundings should be bright and cheerful; and, if possible, all emotional disturbance should be avoided. The mother must be made aware of the bad effect of emotional disturbance upon the quality of the breast milk, and should learn that lactation is only poorly performed by a nervous or excitable woman.

England lags behind France and Germany in the case of pregnant women. Germany relies upon a system of maternity funds, towards which the employer and employed both contribute. In France is organised a Society for Nursing Mothers. The pregnant woman is kept in a home some weeks before her confinement, and then drafted into a maternity hospital. There are also relief-bureaux, which help to maintain the mother during the first year of the infant's life, under the careful supervision of a lady patroness and a physician.

Charity in England requires remodelling on similar lines: for promiscuous philanthropy is usually very ineffective, and seldom really benefits either mother or child. In future, the law must protect more stringently women who work in factories or at other employments. The present factory laws stand in urgent need of revision.

Chiozza Money (<sup>has</sup> ~~Rickets~~ and Poverty, p.169) sums up the whole matter by saying that "the nation must set its face against the employment of married women in factories, for the proper sphere of her work is in her own home. ....

..... In the case of factory workers the employer must be made to furnish a maternity fund, and probably if he is thus penalised, he will prefer not to employ married women to the very great advantage of the labour market and the nation".

#### (c) WHILE NURSING THE CHILD.

##### General Considerations.

Every girl should be taught to recognise the beauty and the responsibilities of motherhood, and, when married, should be guided into a proper recognition of her duties towards her children, and a knowledge of how to take care of them. The mother ought to have sufficient pride in herself and family, - so that she would rather endeavour to bring up her own children than throw the burden on the State. Her efforts would entail **unselfishness** or self-sacrifice, but the benefit to her family ought to compensate for the want of pleasurable excitement.

It is fully recognised that no food can compare with the mother's milk in the safe and efficient nourishment of an infant during its first year; and every child would be considered as wholly dependent upon the mother until it is past the stage of weaning, quite as much as when it was nourished in the womb before it had a separate existence. In the study of the problem of mortality, all efforts were directed, in the attempt to check this wastage of life, upon the child itself, and some progress has been made by establishing



depôts for the supply of sterilised milk, or by careful milk modification, and latterly by attempting to improve the condition of the dairies, the method of transit and the supply of pure milk. The weak spot in all these measures is the tendency they have to discourage breast-feeding.

The system, instituted by Professor Coulet of Caen, of establishing a number of free restaurants for the feeding of necessitous suckling mothers, is a step still further in advance of previous attempts to benefit the child. The crux of the whole matter is to concentrate on the mother and encourage breast-feeding. These restaurants are able to provide for mothers two meals a day, at a less cost than supplying sterilised milk to the child. The only qualifications for admission are poverty and breast-feeding. The charity is administered on broad principles that must command the highest admiration and approval: no questions are asked, creed and morality are not inquired into, and its doors are open to rich and poor. "They are mothers, they are hungry, that is enough!"

The experiment is also being tried in Dundee and Blackburn; and it would be to the nation's advantage, if these institutions, under a wise and broadminded management, could be established in every town. The feeding of the mother, to enable her to nourish her infant, is surely a step in the right direction; and, in the future, it ought to lead to even better results than those obtained by milk depôts, or the excellent institutions known as the "Goutte de Lait".

#### Breast-Feeding.

The expectant mother should early recognise and realise how important it is, both for her offspring and for the future of the coming race, to rear an infant on maternal milk. She should be taught that, though artificial feeding adds to the dangers of life in the case of her own infant, the evil may spread far wider: for the function of breast-feeding, if left unused, may gradually disappear, and her daughters, when they in turn become mothers, - though anxious and willing to do their duty, - may be unable to suckle their infants. The mother must also understand that suckling an infant beyond the normal period is also a dangerous and vicious practice, as the milk tends to deteriorate towards the end of the first year, and is deficient in the valuable proteid element.

In order to prevent infantile disorders and the further spread of rickets, the mother must be assisted, by all means possible to keep her infant at the breast; and every effort should be made to encourage a woman to make the utmost use of her resources, by watching the quality and quantity of her milk, by regulating the mammary secretion, by careful attention to her diet, and by exercise and sleep.

The mother should be guarded, as far as possible, from all worries or emotional disturbances. The pleasures of society must be avoided; afternoon bridge-parties may lighten a mother's purse, but if, at the same time, she is striving conscientiously to nurse her infant, such unnatural excitement will certainly diminish the secretion of maternal milk. It is the duty of the rich, by good

example, to encourage the mothers of the poor.

From the earliest days, the breasts must be attended to with scrupulous care, and the nipples carefully cleansed with warm water, or, if necessary, an antiseptic solution.

The infant must be taught regular habits, almost from the day of its birth; it should be fed "by the clock", and not allowed to sleep beyond the usual hour for food.

If the mother is exhausted by illness, want of sleep, or worry, it is often advisable to remove the child to another room at night, and feed it by the bottle to enable her to obtain a thorough rest; and, by adopting this course, the quality of the milk given during the day is greatly improved.

Unless the mother has a strong constitution, it is a wise rule to desist from feeding the child at the breast during the night after the first five months: for this often enables lactation to be carried on for a longer period.

Infants nursed at the breast may have frequent curdy and slimy motions, if there is a deficiency of the nitrogenous elements; with starvation, there may also be slight pyrexia, and the condition may be improved by giving a few extra meals of modified milk. If the proteids show signs of being low, or the milk poor and scanty, efforts must be directed towards the improvement of the mother's methods of living and her habits thereof. The baby should be taken from the mother at night, and, if possible, she should be kept from worry and anxiety.

Her diet should be nutritious but simple, containing a high proportion of meat, eggs, and milk, but there should be an avoidance of overfeeding. Extract of malt or iron may also prove of value. In the later stages of lactation, little can be done, but, in the eighth month, beef-juice is of especial value, as it seems to supplement the deficient proteids of the mother's milk.

Lactagol - a preparation from cotton seeds - is stated to have a powerful action on the secretion of the mammary glands. It has been employed by Goldmann (Therap. Monat., July, 1904), and the dose recommended is four teaspoonfuls a day.

An infusion of aniseed is said to increase the flow of milk; and Burzagli (Pediatr., April, 1906) combines this treatment with the application of cold compresses to the breast.

It is not necessary to give large quantities of stout, or any form of alcohol, to the nursing mother. If the milk is excessively rich, the infant suffers from indigestion and colic, the stools are pasty, and it loses weight. When this occurs, the mother must be encouraged to take more exercise, especially walking, in the open air, the amount of meat in her diet must be reduced, and it is advisable also to cut off all alcohol. It is possible for a mother, through sheer devotion and anxiety, to do the best for her infant to overfeed herself, and in this way upset the digestion of her child. Unless the diet is carefully supervised, and exercise freely indulged in, the maternal milk may become too rich, and the child suffer from colitis and diarrhoea.

A case of fat indigestion, in a child fed on mother's milk, is reported by W. Northrup (Arch. Ped., 1905, p. 908):

the milk, when examined, showed that the percentage of fat was 8.98, which was reduced to 4.90 by arranging the diet and exercise of the mother.

If suffering from anaemia, a woman may give a milk abundant in quantity, but of poor quality. It has a low specific gravity, and contains very little fat. If the woman is taking large quantities of fluid or alcohol, the milk is little more than an exudation from the blood-vessels into the breasts. In these cases it is impossible to improve the condition of the milk, and it is better to resort almost at once to artificial feeding.

Lactation is to be discouraged if the mother becomes pregnant: for the infant at the breast may grow up delicate, or of nervous temperament, or even mentally weak. There is also great danger that the mother will miscarry, or the child be born with a lowered vitality, and the mother's health undermined for some considerable time. It is but seldom that the mother has sufficient strength or blood to be equal to the strain of feeding three people, - herself, a foetus, and a suckling child.

It is very important always to insist on regular hours for the feeding of an infant, whether at the breast or the bottle, every two hours for a young infant; after a month or six weeks, every two and a half hours; and after three months, at least three hours should elapse between each feed. The infant must not be fed every time it cries, but an endeavour made to ascertain the cause: for it is more often uncomfortable with colic, or with wet napkins, than restless from hunger. If it is thirsty, small drinks of water are beneficial, and, as infants frequently have uric-acid infarcts, the use of water would help to thoroughly flush the kidneys.

The character of the stools must be carefully noted, the infant weighed once a week, and the gain or loss entered upon a chart, together with notes of its general condition.

Rickets occasionally appears in a breast-fed infant, if the milk is deficient in proteids and fat, and given for a long time past the normal period of lactation.

Breast milk is apparently no safeguard against rickets after the first year; and Louis Fischer (Internat. Clinics, S.xvi, Vol.ii, p.132) reports, with an illustration, of a case of rickets developing in an infant at the breast. The child was brought up on breast milk in a poor family living in bad hygienic surroundings, which doubtless injured the vitality of both the mother and child, and produced the disease.

The writer at present has under observation a breast-fed infant, aged one year, that presents marked signs of rickets - especially about the head and extremities.

#### Mixed Feeding.

If the supply of breast milk is small, it can be safely supplemented with cow's milk, given at alternate feeds, or in conjunction with the mother's milk. It is an erroneous idea to suppose that the two milks cannot be given together. If the breasts yield only a small quantity of milk, or milk of poor quality, it is a good



practice to give the child a small feed of cow's milk before putting it to the breast, as it will then not suck so ravenously. The infant also benefits by deriving a regular supply of ferments from the maternal milk, and this is a matter of considerable importance in the prevention of rachitic disease.

J. L. Morse (Jour. Amer. Med., Aug. 2, 1902) advises using both breast and bottle at each feeding, in order to take advantage of the ferments in the breast milk; and Professor Budin (Le Progr. Méd., July, 1902) also approves of the method of mixed feeding. In his work, "The Nursling", he shows, and illustrates with charts, the good results that can be obtained by mixed feeding with breast milk and small quantities of sterilised milk; and he insists (ibid., p. 122) that the results can easily be controlled by checking the child's weight at frequent intervals on the balance. He also considers this method of great value in the case of women living in the whirl of society, who may be ready to suckle, but produce little milk: for their deficient supply can be safely augmented by sterilised milk.

Where two children have to be fed, as in the case of twins, mixed feeding relieves the strain on the mother, and enables her to keep both infants at the breast for a greater number of months. The method ought always to be tried before finally resorting to feeding by artificial means.

#### Weaning.

For the good of both mother and child and the prevention of malnutrition and rickets, weaning should not be delayed after a certain period. The child should be weaned after the ninth month, and it is advisable to accustom it before this date to occasional feeds from a bottle, - so as to make the transference from the breast to artificial feeding a gradual process, as well as one of comparative safety.

If the weight of the infant remains stationary for a time, or a steady loss is noted, the indication is for a discontinuance of breast-feeding, and a need for weaning lest nutrition should suffer.

Any signs of rickets in a breast-fed infant demand immediate discontinuance of feeding at the breast - especially if the child has passed the age of nine months, or is over a year in age.

#### Prolonged Lactation.

The foolish idea, that prolonged suckling will prevent conception, is responsible for many infants being kept at the breast many months after the end of the first year.

Prolonged lactation can only result in an insufficient nutrition, and with a low percentage of proteids: for these fall very rapidly about the end of the first year. An early sign of an insufficiency of proteid in the diet is delayed dentition.

The mother must be warned that the persistence in suckling will inevitably result in the impairment of her health and the starvation of her child, and that she is also vitiating all the benefit derived from the breast-feeding during the first year. She ought to fully realise that, unless the infant is weaned at the proper

physiological period,rickets is as likely to develop in a breast-fed infant as in a child reared on the bottle, or by artificial means.

#### Instruction of the Mothers in Maternal Duties.

It is often advisable to stimulate the interest of the mother in the growth and development of her infant, and, by hints and advice, to teach her to watch for signs that may indicate a normal rate of physical and mental progress, or the onset of some slight affection.

This instruction in elementary details can easily be given by the medical practitioner; and the writer is accustomed to recommend to mothers certain books, from which they can supplement their knowledge.

The best book for general reading is undoubtedly Ashby's "Health in the Nursery", and the chapters on the mental development of the infant enables the mother, from month to month, to check carefully the growth and progress of her child. For others, who may prefer literature in the form of a catechism, a little book, entitled "The Care and Feeding of Children", by L. Emmett Holt, is useful. "The Child's Diet", by Curgenvin, contains many hints of value, and some useful cookery recipes. The list of starchless puddings may be referred to as of great value in the treatment of children who are suffering from digestive disorders produced by an excess of carbohydrates in their food. The series of lectures published by the St. Marylebone Health Society, entitled "Infant Education" (Eric Pritchard), should prove of assistance to mothers, and it contains instructive appendices.

The information gained from these books can soon be put into ready practice in the nursery, tends to make the mothers more capable and efficient, and supplies fresh interests in the daily work and care of the child.

If the mother can be persuaded to keep a diary of the life of the child, much valuable information can be recorded, and its value enhanced by the addition of a weight-chart and snap-shot photographs of the offspring. As a volume of reference and a history of the life of a child, its growth, progress, development, and illnesses, it proves in later years of considerable value to the parents, and also to the medical man.

#### Instruction of the Midwife.

Amongst the poor, when the services of a physician cannot always be afforded, the midwife should be able to give better information about the upbringing and care of infants, or the rudiments of feeding by artificial means. At the present time, their advice and methods are based on ignorant notions, and are liable to do harm to mother and child. Their education in the management of infants should be more thorough and complete, - so that they are better equipped to afford proper assistance to women who rely on their services.

#### Lady Inspectors and Lecturers.

If births could be registered within forty-eight hours, Lady Inspectors - by means of tactful visits and conversation - could afford valuable help and assistance. At first, however, they must be prepared to meet with much discouragement. Dogmatic teaching as to fresh air, cleanliness, the preparation of food, the feeding and care of children may be listened to with

chilling silence, sullen indifference, or angry rebuff. Lectures and scoldings may fall on deaf and unheeding ears. But, if cheerfully persistent, and a little time is given to an explanation of the scientific reasons why these things are advantageous, the subject becomes clothed with fresh interest, and the woman, now more friendly disposed, may listen readily and take pains over daily work, or the minor details in the care of her home and infant, that were only drudgery before, or pushed aside because they were not worth the trouble. She will slowly recognise that there is a good reason why one feeding bottle is preferable to another, and realise that care and cleanliness may save her child from "frog in the throat", and many petty ailments and discomforts, or even grave disease. She may even be persuaded to discard the dummy teat, but more often will persist in using this most dangerous of soothing remedies.

#### Instruction of Relatives.

It is often possible to educate the mother, but the grandmother, relying on her age, will seldom listen to reasonable advice. It would seem impossible to prevent the mischief wrought by the grandmother in many a home. Because she has reared a family in haphazard fashion and lost many an infant, she will pose as a person of authority and experience in infant feeding, and frequently interferes in the nursery, and countermands the directions of the physician, because she does not hold or agree with his "new-fangled" notions. Therefore, it is only by the education of the present generation of mothers that a wiser type of grandmother can be evolved, who will be able to give valuable assistance to the daughter, and not prove an hindrance to the rearing of infants in the future.

#### The Bonus System.

It is to be hoped that, in the days to come, it will not be necessary to offer bonuses, in order to encourage mothers to nurse their infants at the breast.

Every credit is due to Mr. Broadbent, when Mayor of Huddersfield, for his pioneer work and zealous efforts to reduce the mortality in his town by the gift of a pound bonus to mothers at the end of the first year of their infant's life; but that such a method is needed in the twentieth century, is a shame and a disgrace to the mothers of our land.

The sense of pride and maternal responsibility should alone be sufficient to stimulate every mother to nurse her offspring, and cause her to delight and glory in the progress of the infant daily nourished at her breast.

#### Facts of Particular Importance.

The discussion of the care of the pregnant woman, and the efforts to promote breast-feeding by attention to the health and welfare of the mother, may seem, at first sight, an unwarrantable intrusion into a thesis dealing with the subject of rickets. The writer would argue that the first main principle which must be grasped, if the prophylaxis and treatment of rickets is to be sure and thorough, is the need for concentration on the mother, the promotion of her health and welfare,



and the encouragement of feeding every infant at the breast, unless there are grave indications to the contrary.

When the medical man and philanthropists have joined hands to urge the education of women to a better standard of womanhood, and have taught them to aspire towards the highest ideals of maternity, and to realise the sacred responsibilities owing to their infants, the need to a very great extent will disappear for the unsatisfactory treatment of so widespread a disease as rickets, when developed in the child.

It may be still necessary, by better homes properly drained and ventilated and lighted, to improve the environment and mode of life, before it can be possible to reduce or stamp out the large percentage of rickets present in every town of Europe.

"Back to the breast!" is the foreword, and the first urgent requirement for the efficient prophylaxis and treatment of rickets.

## T H E C H I L D.

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### (A) T H E D I E T.

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After the birth of the child its needs should receive immediate attention, and therefore, if the notification of all births within forty-eight hours to the municipal authorities were made compulsory, early errors might, by timely and tactful visits from qualified Lady Inspectors, be avoided.

If a medical man is in attendance, it is essential that the child should not be forgotten during the period in which the mother is tided over the dangers of the puerperium. If nursed at the breast, the physician must satisfy himself that the quality of the milk is good, and that the child is fed at regular intervals. He must not remain satisfied with the statements of the midwife or hospital nurse. This, to our discredit, is often the case: for mothers with young infants have often affirmed that the doctor gave them unremitting attention, but never took any interest in the child, leaving it entirely to the nurse's care; and they openly express surprise if the medical man personally exercises supervision over the child's daily life and diet.

It is important also that midwives should be better educated in the principles of infant feeding: for, at the present time, their knowledge seems largely derived from popular fallacies, antiquated theories, or their own imperfect experience.

If there is a history of rickets in the parents during infancy, or if the elder children have shown signs of the disease, special precautions must be taken, as the predisposition to the affection increases with each successive child. The medical man must also take due regard of the environment of the child, paying special attention to its home and the details of its daily life - the supply of fresh air and sunlight, its baths, exercise, clothing, and feeding. Infantile mortality and rickets are both largely due to improper feeding: in the former, death may result from insufficient nourishment, but the

appearance of rickets is more often due to overfeeding of the child with food stuffs ill adapted to its age, growth, and development. This deplorable state of affairs is often due to carelessness, laziness, and ignorance on the part of the mothers. If the child is at the breast, it is often suckled by the mother long after the milk has become useless as a food, or suitable for its proper nutrition; and this is not done so much for economical reasons, as from a foolish attempt to prevent the occurrence of conception.

Strauss accurately sums up the condition of affairs when he says that: "The mothers of today do not know the A. B. C. of their business".

Their ignorance is frequently appalling. Even in well-to-do circles of society, mothers often do not seem to understand the elements of infant feeding, and rely upon the well-meant, but harmful, advice of the grandmother and nurse, or the recommendation of friends, whose babies are supposed to have been reared with great success on one or other of the proprietary foods. The pernicious system, adopted by manufacturers in sending samples of patent foods and booklets of advice to these fond but deluded mothers, may often lead to the use in an infant's early life of unsuitable food, which leads to a train of digestive disorders that can only end in diarrhoea or rickets.

Some modification of the Roussel law would be of service in England, prohibiting the use of solid or patent foods, which should be scheduled, and never prescribed to an infant under the age of nine months, except under a physician's prescription. In France also, nurses are forbidden to use, in the rearing of infants confided to their care, - at any time, or under any pretext whatever, - a bottle provided with a long rubber tube. These tubes, however careful and cleanly the mother may be, in time become incubators for germs or repositories for toxins, and also lead to carelessness and lazy methods in the feeding of infants. The sale of such articles should be forbidden by law.

#### Artificial Feeding.

If the mother is unable to suckle her child, the question of artificial feeding needs careful consideration: for if, in the early days improper methods are employed and rickets should develop, the disorders of digestion may be so troublesome that ordinary modifications of milk will be found ineffective or even dangerous.

In order to derive good results from artificial feeding, - especially when applied to delicate or rachitic children, - it is absolutely necessary to be able to obtain a supply of cow's milk that is pure, free from contamination, and of good quality. In large towns the supply of milk - especially if brought from the country some distance by train - is far from satisfactory, but, in outlying districts, the milk from a good dairy, with intelligent and cleanly handling, may answer all requirements.

There are three kinds of milk that are used for the purpose of infant feeding:

- (1) Pure milk from a dairy.
- (2) Certified milk with low bacterial content.
- (3) Sterilised milk supplied by a dépôt.

(1) Pure Milk.

If it were possible to rely upon a supply of clean pure milk, the necessity for sterilisation might disappear. In the near future, it is to be hoped that milk will be more rigidly inspected, and dairies compelled to take greater precautions. If the milker is cleanly in person, the cow's milked in the open, the fluid received in sterile pails, strained, and immediately put aside in a refrigerator or cold water, the risk of outside contamination and the growth of organisms can be very largely prevented.

G. Newman, in his work on "Infant Mortality", shows that it is possible to obtain a supply of fairly pure milk: for, with only ordinary supervision of the dairy and ordinary precautions, the Finsbury Milk Depot receives a daily supply of reliable clean milk.

The principles/precautions it is necessary to insist upon are:

- (a) Direct control of the milk at the farm.
- (b) Treatment of the milk immediately after its yield, before it is invaded by microbes.
- (c) Medical supervision of the depot, and of the infants consuming the milk.

If the milk can be obtained pure, sterilisation would be unnecessary perhaps, but it is further essential that it is properly handled when received at the home of the child. The milk should be poured into a clean and scalded utensil, kept cool, and properly covered; the feeding bottles and teats should be kept in clean water, be above suspicion of any taint, and all outside sources of contamination avoided. Milk should never be left in the feeding bottles. As far as is practicable, it should be delivered to the consumers in air-tight containers. The milk is usually supplied in glass bottles, but ~~latterly~~ it has been found that fewer microbes grow in those made of paper, which are cheap and can be destroyed after use.

The writer considers that the small pith discs are preferable to the glass stoppers with metal fittings: they can be destroyed after use, and, if necessary, rendered more air-tight by a coating of melted wax or paraffin.

(2) Certified Milk of Low Bacterial Content.

The average number of bacteria in cow's milk, taken from ordinary cans or bottles, contains 100,000 to 10,000,000 bacteria per cubic centimetre.

In order to improve the standard of milk, several medical societies in America, - notably in Philadelphia, Chicago, and New York, - by means of Milk Commissions, have endeavoured to obtain a milk with a less dangerous number of micro-organisms. They have found it possible to put on the market a milk that is certified to have a bacterial content below 25,000 to 30,000 bacteria per cubic centimetre, with an average composition of 4 per cent. butter-fat, and 3.5 per cent. of proteid. The co-operation of the dairyman is essential: for he is obliged carry out the precautions necessary to ensure good certified milk. He must carefully sterilise the dairy utensils and bottles, remove the manure from the stalls,



carefully groom his cows, and wipe the udders, before milking, with a damp cloth. The milk is bottled and sealed, in order to prevent any tampering before it is delivered to the consumer. All milk carries with it a label of its date; it is inspected and tested at periodical intervals; and a special certificate is issued to the dairy, if the milk comes up to the standard of purity and requisite composition. The regulations and precautions to be taken in the cowsheds, and in the process of milking and bottling the supplies, have been fully drawn up in a clear and concise form by the Milk Committee of New York (Arch. Ped., Vol. xix, p. 619).

The use of certified milk appears to the writer to be a step in the right direction towards obtaining a reliable food for infants; and, if this milk could be introduced into England, the need of depôts for the supply of sterilised milk would not be so urgent a necessity in our large towns. It is surely better to endeavour to obtain a supply of good pure milk than to sterilise a milk full of poisonous products!

The disadvantage of certified milk is a slight increase in the price to the consumer; this, in New York, is about 20 per cent. above that of ordinary milk. The ordinary bottled milk costs 8 cents, whereas certified milk is sold from 10 to 15 cents. If the public could be educated to recognise the advantages to the infant derivable from a purer milk-supply, the increased demand might help to reduce the initial cost of its preparation. If reports of the milk were sent to all medical men in the district, it would give them great assistance, and would enable them to advise parents where to obtain reliable milk, and also stimulate the keepers to a greater degree of efficiency.

### (3) Milk Depôts.

Owing to the impure condition of the milk, - especially in hot weather, - the bad and slow methods of storage, and of transit from the farmer to the consumer, and the dirty dairies or shops from which it is often purveyed to the poorer classes, it is often necessary in large towns to supply bottles of sterilised milk from various depôts. These depôts have proved very valuable in assisting to reduce the great infantile mortality from epidemics of summer diarrhoea. It seems to the writer that it is possible to make them more effective as places of instruction for mothers and junior medical practitioners, if they were placed under medical instead of municipal control. They would become centres of education, instead of being only shops for the distribution of milk to mothers.

The French "Consultations de Nourrissons" and the "Gouttes de Lait" are more effective: for at these establishments they instruct the mothers, examine and weigh the infants, in addition to supplying applicants with the milk requisite for the nourishment of the child. Professor Budin wisely insists that only the mother is allowed to bring the infant for advice and food.

The work of the "Consultations de Nourrissons" is principally confined to the treatment of breast-fed infants, whereas the "Gouttes de Lait" are dispensaries for the supply of sterilised or prepared milk to the

poorer classes. A full account of the English and continental systems is given in G. F. McCleary's book on "Infantile Mortality and Infant Milk Depôts".

The writer is of the opinion that, if milk depôts organised as "Consultations" were established throughout the country, they might become valuable schools in which young medical practitioners would be able to watch and study the growth of infants during their first two years, and thoroughly learn, in a practical manner, the rational methods of infant feeding. The "Consultation" for the study of infants ought to displace the classroom. During the final year of his curriculum, the student has so much to learn, and is so fully occupied with lectures and ward work, where he becomes absorbed in the details of interesting cases in medicine and surgery, that he is unable or unwilling to devote any time to the minor subject of the care and feeding of infants. But, when qualified to practise and to advise mothers in the management of their children, and more especially during the years when he is laboriously and slowly endeavouring to build up a practice, he has much spare time that could usefully be employed in daily attendance at a milk depôt or infant consultation, where he could learn how to examine the infant, and accustom himself to prescribe and modify its daily proper allowance of milk. As these children were brought up week after week for weighing and inspection, he would be able to follow the cases in their gradual growth and development, - so that this class of work would prove a source of interest and instruction; and he would become a more efficient practitioner in the future, fully trained to advise the mothers in the proper treatment of their infants. He would learn to rely more upon the arrangement of the child's diet, and less upon drugs in the treatment of the diseases in early life.

The writer would like to see the establishment of consultations in every village or district: for they would prove of inestimable benefit to the practitioner of the future, as well as to the entire community. That these consultations would require to be safeguarded from abuse is only too probable, but, if all the medical men of a district were equally interested in the management and control, these establishments ought not to clash with their interests or interfere with private practice. Cases of rickets could be early detected, and the mothers instructed to take their children to their own medical adviser, or be sent to the hospital for further advice. A somewhat more Utopian scheme would be a building containing a restaurant for nursing mothers, a consultation for the inspection of infants, and the supply of proper milk, as well as a crèche or nursery in which delicate children could be watched from day to day. Rickety children might possibly be treated better by careful supervision of the mother and child than by attendance at out-patient departments, or admittance to hospitals.

J. Fortescue Brickdale (Brit. Jour. Childn. Dis., Vol. ii, p. 506) does not believe it possible to organise in England the medical supervision of children which

obtains in France, and affirms that the depôts would either remain unused, or have to be converted into outpatient dispensaries. In their stead, he advocates the supervision and weighing of the children at home by Lady Inspectors.

Doubtless many mothers would not trouble to bring their infants, or send for milk if they could have it cheaply delivered at the doors of their homes; but the experience of Professor Budin suggests that mothers can gradually be educated up to the value of these institutions, and in time learn to appreciate the value of bringing their infants weekly for advice and the regular supply of food. By comparing their own infants with others at the consultation, a healthy spirit of rivalry might be set up, and maternal pride awakened and stimulated by the growth and progress made manifest by the child's condition and the figures in its chart.

George Carpenter's scheme of attaching the milk dispensaries to children's hospitals deserves careful consideration: cases requiring feeding and medical treatment for malnutrition or rickets could then be quickly and more successfully dealt with; but this plan would seem only feasible in towns large enough to support these special institutions, and the method would not prove of value at all in the education of medical men other than those upon the staff.

To obtain the best results, it is necessary to organise consultations throughout the country, even in the smallest villages; and the writer believes that, though at first progress might be slow and unsatisfactory, their immense value, as educational centres for mothers having the care of infants, and their value as depôts for obtaining clean pure milk, not necessarily sterilised, would in the end lead to their systematic use, and cause them to be appreciated by all classes of the community. It is only necessary to commence in a simple way.

Mons. Jonnart writes: "To create a consultation for infants three things suffice: a pair of scales, and apparatus for the sterilisation of milk, and the devotion of a doctor".

A system of "Consultations de Nourrissons" is better than one of Milk depôts: for, at the former, nursing mothers can be encouraged to attend and receive advice during stated periods, their babies can be examined and weighed, and, if necessary, extra milk can be supplied in sufficient amount, or modified to the needs of each individual child.

Professor Budin suggests that, if the mother is in receipt of monetary aid, only the full grant is allowed if the breast is sufficient to nourish the infant, and if milk is required, its cost is to be deducted from the mother's subsidy. His suggestion is excellent, but there is some danger that the mother, fearing to lose part of her subsidy, might not apply for the sterilised milk, but supplement the insufficient supply from the breast by milk of inferior quality obtained at home, or even resort to the use of one of the patent foods, and thus spoil all the careful feeding conducted at the consultation.



The great objection to the Milk Depôts, which does not apply to so great an extent to the "Consultations", is the possibility that they may tend to encourage artificial feeding at the expense of breast-feeding.

G. F. McCleary (Infant Milk Depôts, p.109) is not aware that any evidence has been brought forward to substantiate this charge.

If medical supervision of the infants is insisted upon, the writer feels assured that mothers could, often be encouraged to persist in breast-feeding beyond the early weeks, that many infantile disorders (such as diarrhoea) could be checked, and rickets detected and treated in its earliest stages.

Professor Budin closes his valuable lectures with these words of wholesome advice, in which all must readily concur: "Whether your lot be placed in town or village organise consultations for nurslings". The advantages to the mother, the infant, and the medical practitioner of the future would be incalculable, and have far-reaching consequences for the good of posterity.

Nevertheless, there is some danger in providing too great facilities for obtaining good cow's milk. The greatest incentive to breast-feeding is not an ample supply of cow's milk, but an inability to obtain it.

During the siege of Paris (Franco-German War), the adult death-rate rose 40 per cent., but, as the mothers were obliged to nurse their offspring, the infantile mortality was considerably reduced.

But, where there is easy access to a constant supply of cow's milk, either whole or modified for the requirements of the infant, it may make mothers careless or liable to resort too readily to artificial feeding, in order to save trouble, or to enable them to live a life of pleasure. If mothers are impressed with the fact that their babies cannot live or attain adult life, unless fed at the breast, it might stimulate every woman, worthy of the name of mother, to nurse their infants, and fulfil their duties to their offspring, as well as to the coming race. They should be made to realise fully the many perils that beset a child, even if fed with the greatest care on the best methods and modifications employed in artificial feeding, even though it is possible to obtain a good supply of clean cow's milk. They must be taught to realise the physiological advantages and the superiority and safety of breast milk, and the absolute impossibility of approaching so ideal a standard whenever it becomes necessary to rear an infant by artificial means.

#### The Feeding of the Infant With Special Reference to Modifications Required in a Case of Rickets.

In utero, the foetus derives its nourishment from the blood of its mother, and, if fed at the breast, is still obtaining sustenance from the same source: for the quality of the milk will depend upon that of the maternal blood. The maternal milk is specially adapted for the gradual development of the infant's stomach, supplying the relatively small amount of proteid for its slow growth, as compared with the young of other

mammals. It also possesses its own peculiar ferments, and likewise antibodies, or antitoxins derived from the maternal blood, which enable the infant to resist the toxins of various poisons or diseases. The human milk slowly educates the stomach of the infant, being first supplied as colostrum, the full strength of the milk not being present for eight or ten days. It contains a large quantity of lecithin, a compound utilised for building up the nervous system, and this element is not present in so large an amount in the milk of the cow and other mammals.

It is necessary to train the infant's stomach to make the most of both quality and quantity of food, and to extract all the nutrition possible from even a small quantity of the same. In a rachitic child, an abnormal appetite or an excessive thirst may only mean a dilated stomach, or a condition of hyperacidity; and it should be treated by small meals at fairly long intervals, and not by an excess of dilute foods constantly poured into an organ hampered with its own fermenting products. The digestion is certain to be slow and imperfect, and the stomach should be given rest for lengthy periods. Though there are advantages in giving fresh milk, boiled milk may be found more digestible, but its use should be discontinued if nutrition flags or scurvy should appear. In feeding the infant, whether at the breast or on the bottle, the only accurate way of estimating the amount of food taken is to weigh the child immediately before and after a test meal. The time taken over the meal is in no way a true index of the food ingested.

Budin (The Nursling, p. 84) emphasises the importance of the systematic weighing of infants, and writes: "In your practice therefore always have recourse to the balance. Recommend its usage at all times knowing that nothing can replace it as a means by which to estimate the development of the nurslings".

If, by force of circumstances, the mother is unable to nurse her infant, means must be taken immediately to feed it artificially in the best way possible. The great majority of children must be reared on cow's milk, though some authorities consider that, in many ways, the milk of the goat is to be preferred - the chief reason being that the goat is a cleaner animal, - its faeces are passed in form pellets, and not pultaceous like that of the cow, - it is easily groomed and fed, and there is little risk of tuberculosis. The milk is more digestible, as the casein and curd is more flocculent; the fat is oilier, containing less stearine than that of the cow, and both the casein and the fat more closely resemble that of human milk. The percentage composition of goat's milk is - proteid 3.8, sugar 4.3, and fat 5.2. It is, however, by no means always easy to obtain a suitable goat; and, some years ago, when the writer endeavoured to feed an infant on this milk, an animal was only procured with great difficulty.

As a temporary food for infants unable to digest cow's milk, that of the ass may be found of service. The curd is extremely fine, and closely resembles that of human milk, the amount of fat is small, and the milk is somewhat laxative in its action. The percentage composition is - proteid 2.7, fat 1, and sugar 5.3. Except in

large towns, it is not always readily obtainable, and it should only be used for a short time, and not as a permanent food. In general practice, - especially dealing with the poor, amongst whom the majority of the cases of rickets will be found, - reliance must be placed on the milk of the cow.

In artificial feeding the mixture to be ideal must conform as closely as possible to the maternal milk; and, though it is a fairly simple matter to modify the milk of the cow to obtain a fluid with a percentage composition identical with that of human milk, and also partially to rearrange the proportion of casein, very little can be done to alter the nature of the casein curd, or the heavy oleaginous fat. It may be possible in the future, by special feeding of the animal, to supply ferments identical with those in human milk; but, even when all this has been accomplished, no artificial food, in its biological and vital principles, can afford such perfect nutriment as the milk of the mother for her own child. Even the milk of the wet-nurse, to some extent, must fall short of this high standard.

The basis of the nutrition must be maternal milk, which supplies an average percentage composition of - proteid 1.5, fat 3.5, and sugar 6.5, which is faintly acid (to phenolphthalein) in reaction, and also practically sterile. It is advisable to avoid too much chemical refinement, but to study each individual child at the bedside, as each infant is a law unto itself. The amount of food and its character must be judged not by the child's age in months, but by its weight, its capabilities, and the general condition of its development. The careful directions of the text-books - percentage feeding or rule-of-thumb methods - should be discouraged; the food in all cases must be found for each individual child, and deference also paid to a healthy appetite.

In order to carefully arrange a food, the value and uses of its constituents must be always clearly understood and appreciated.

The PROTEID should receive the first consideration, as it is the builder of cell tissue, and the maker of blood; the fat and carbohydrates should be assigned secondary places, as they are largely proteid-sparers and heat-producers. The proteids should not be used up in the production of bodily heat, which becomes necessary if the fats and carbohydrates are insufficient.

The proteids of milk are casein and lactalbumin, which differ in their main characteristics. The milk of the mother contains more lactalbumin, - a more soluble proteid than casein (2 : 1), - whereas the milk of the cow contains five times as much casein as lactalbumin ( $5\frac{1}{2}$  : 1).

The large quantity of the tough indigestible casein is the chief difficulty when the infant is fed on cow's milk, and frequently it is unable to digest the full amount present in human milk (1.5 %). The infant should be able to digest a milk mixture, containing 1 per cent. of proteid, at the end of one month, 1.5 per cent. at three months, and 2 per cent. between the fourth and fifth months; but it is seldom able to digest pure cow's milk,



or 3.5 per cent. of proteid, before the end of the first year.

The stools of an infant should be carefully inspected from time to time: for their colour, consistency, and the presence of undigested casein all indicate the adaptability of the food to the child's digestion and strength. If the proteids are too low, the child suffers from starvation, it does not gain weight, sleeps badly, is very fretful, the extremities are cold, and the temperature is subnormal. The stools are green in colour, like spinach, and contain particles of undigested curd, they have little consistency, but are seldom watery, and often contain mucus. It is often difficult to decide whether the condition of the stools is due to excess or deficiency of proteids. If the proteids are too high, the infant's digestion is disturbed, and there is almost invariably colic, which does not occur if the proteid is low. The stools are more often watery, and contain large masses of undigested curd. There may also be an increase in the child's temperature.

FAT is specially required by the body for the elaboration of the nervous and osseous systems. It is also a heat-producer, and spares the proteid from being drawn upon to maintain the bodily heat.

The infant requires a greater proportion of fat in its food than the adult; and Budin states of the number of calories, in its average ~~nation~~ <sup>5.3</sup> per cent. come from butter, 29 per cent. from sugar of milk, and 18 per cent. from albuminoid substances. An infant requires 100 calories per kilogram of body weight every twenty-four hours, and in tiny infants the number is relatively greater.

The most noticeable effects in rickets are seen in the disorder of the osseous and nervous systems, - so that it is reasonable to suppose that fat will play a considerable part in the treatment and the cure of the disease. Clinical experience supports this view; but there are two pitfalls that the unwary may fall into, if the fat is allowed to predominate too largely in the diet - the first being a tendency to increase the fat unduly, without paying due regard to the proteid element, which may result in tissue starvation, and even loss of weight; the second, a ~~disposition~~ <sup>propensity</sup> to give an excess of fat, usually in the form of cream, thereby producing fat indigestion, which may be wrongly attributed to the disturbances of rickets, and, if persevered in, causes profound toxæmia or autointoxication. The fat of cow's milk is rich in fatty acids, the human milk being poor therein; the amount of fat present in both milks being equal (4 per cent.), young infants can seldom digest or assimilate 4 per cent. of cow's fat and thrive better with 3 or 3.5.

Indeed, Jacobi states that infants make steady progress and gain weight on a diet containing only 2 per cent. of fat; and the Strauss milk, made according to his directions, only contains this amount. G. Still, however, considers anything under 3 per cent. of fat as unsatisfactory; and Holt advises:

1 per cent. of fat on the 2nd day.

2 per cent. at the 1st week.  
 3 " " " 3 or 4 weeks.  
 4 " " " 4 " 5 months.

It is always advisable to lower the percentage of fat in the food during the hot weather.

In treating a case of rickets, it is irrational to increase the fat too rapidly: for dyspepsia, hepatic disturbance, and fatty stools are produced, and the infant becomes ill and loses weight. In overfeeding with fat the stools are usually yellowish, and contain very little casein. There may be flatulence, and the motion is often passes suddenly with a slight explosion. It is usually mixed with a great deal of glairy mucus. The child is uncomfortable, the stomach is distended, and it may vomit sour, undigested, and curdled milk. There may even be a disposition of this excess of fat in the tissues, leading to increase of weight - yet the child is fat, flabby, and still suffering from rachitis. Therefore, the amount of fat should be carefully checked: for it may happen that additional fat is also given in the form of medicine - usually phosphorated oil, cod-liver oil, or possibly cream or bacon fat. It is wiser to keep a normal ratio between the proteids and the fats, rather than raise the latter element too unduly, in the hope of rapidly curing the disease. The constipation of rickets does not always call for an increase of fat, but may mean a readjustment and strengthening of all the elements of the diet. If the infant does well on a low percentage of fat, it is important to take care that no excess of carbohydrates shall interfere with the proper of the same.

G. Still (Practitioner, 1905, Sept.) considers that 1.5 per cent. of fat, for an infant of six months, is no safeguard against rickets, and, if there is an excess of carbohydrates, 2 or 2.5 per cent. may fail to prevent the appearance of the disease.

The best food for infants, of a fatty nature, is cream: for it is in a fine state of emulsification, and is easily digested and assimilated. The value of fat as a proteid-sparer cannot be overestimated. If the proportion of fat is reduced too low in the diet, nutrition suffers and rickets may supervene; but it may be partly brought about by using up the proteid to do the work of the fat, with consequent loss of tissue metabolism. Therefore, though the diet of the rachitic child must contain abundant fat, it must also have a due proportion also of proteid, carefully adjusted to suit each individual case.

The SUGAR can be converted into fat, but its principal use is a sparer of proteid, and as a source of heat and energy. It is essential that the carbohydrate for the early months of life should be in the form of sugar: for otherwise it may interfere with the absorption of the fat. If cow's milk is used in the feeding of the infant, it is advisable never to give less than 5 per cent., and seldom more than 7 per cent. of sugar. The simplest and readiest plan is to prepare a 5 per cent. solution of milk-sugar, by dissolving one ounce of sugar in twenty ounces of boiled water, and this can be

added to the food as required. The price of milk-sugar prohibits its use amongst the poor, and, if cane-sugar is the sweetening agent employed, only half as much as milk-sugar will be required.

Cheadle (Artif. Feeding of Infants, p. 39) gives six essential conditions or AXIOMS, which sum up the points to be observed in the selection and preparation of an infant's food:

I. The food must contain the different elements in the proportions which obtain in human milk.

II. It must possess the antiscorbutic element.

III. The total quantity in the twenty-four hours must represent the nutritive value of one to three pints of human milk, according to age.

IV. It must not be purely vegetable, but contain a large proportion of animal matter.

V. It must be in form suited to the physiological condition of the digestive function in infancy.

VI. It must be fresh and free from taint or decomposition.

These rules form a good bases on which to construct a food for a healthy or sick child. In dealing with cow's milk, it must always be remembered that it is impossible to convert it into human milk: for it is intended to develop the digestive tract of the calf, and can never be quite adapted to the infants stomach. But, if cow's milk must be used, the most essential factor in successful feeding is a proper supply of fresh clean cow's milk. It is advisable to weigh the child at least once a week, and, if it is gaining weight and the stools are normal, the diet may be regarded as satisfactory. Special attention must be given to the muscular system, and an undue disposition of fat in the tissues should lead to the readjustment of the diet.

It cannot be said that there is any special diet for the rachitic child, but the most important point is a good knowledge of the feeding of the normal infant, - so that the modification can be made from this basis.

The main object in the feeding of a case of rickets is to endeavour to place it upon a mixture as rich in fat as can be safely digested and assimilated. But, with this idea always in view, it is equally certain that the rachitic infant, when first brought for medical advice, is suffering from disorders of the gastro-intestinal tract (indigestion, diarrhoea, colic, or other digestive troubles); and the first care of the physician must be to correct and soothe the irritated and inflamed organs, and the feed the child on a bland and easily digested food, possibly withholding milk altogether for some little time. Whilst the way is being prepared for a more nutritious diet, it may be necessary to practically starve the child, according to the digestive complication present, but to allow it plenty of fluid - in the worst cases, possibly only water containing sugar of milk or egg-albumin. If milk is not tolerated, various temporary foods may be tried - amongst which may be mentioned whey and white-wine whey, buttermilk, vegetable and malted soups, and dextrinised gruels.

WHEY contains the soluble proteids of the milk, but it is free from the insoluble casein that forms the tough indigestible curds. It also contains a small



quantity of fat, sugar, and water. The composition of the whey depends upon the quality of the milk from which it is prepared: for whey made from whole milk will naturally contain more fat than that obtained from skim-milk, - but it makes little difference in the amount of the soluble proteid.

Van Slyke gives the following analyses of whey made from different kinds of milk:

	3 % Fat.	4 % Fat.	5 % Fat.
	From Poor Milk.	Medium Milk.	Rich Milk.
Total solids .....	6.87 .....	6.96 .....	7.38
Fat .....	0.28 .....	0.30 .....	0.30
Total Proteids ...	0.69 .....	0.87 .....	1.03
Sugar and Ash ....	5.90 .....	5.79 .....	6.04
Water .....	93.13 .....	93.04 .....	92.62

If the whey be cloudy, it contains some of the paracasein and a little fat. The whey proteids are lactalbumin and lactaglobulin, but, as the latter is only 1 per cent. of the total proteid, it may be disregarded.

The use of whey enables a food to be given with soluble proteids, together with a small quantity of casein if required. It is frequently referred to in artificial feeding as "split proteids", and ~~it~~ often it is advantageous to feed an infant with "split proteids" and fat, when it is unable to digest casein. Whey is a good food in rickets: for it contains all the lime and phosphates of the milk.

The preparation of whey, though simple, requires a little care. The milk should be heated to about 100° F., and the rennet then added. The rennet should be obtained in a solid form, or as a curdling fluid; tablets of rennin are also very convenient. The milk is now heated to 155° F., preferably in a double saucepan; when the curd forms, it should be cut with a knife to allow the whey to escape. It is then strained through muslin or cheesecloth, and, if more casein is required, the casein should be thoroughly broken up at the same time. Before use, the whey should be reheated to destroy the rennet ferment.

H. J. Mitchell, of Toronto (Brit. Jour. Childn. Dis., Vol. iii, p. 36; Canadian Jour. of Med. & Surg.), points out that whey must be heated to 155° F., before cream is added, in order to prevent coagulation, but that it must not be heated above 166° F., else there will be coagulation of the lactalbumin. It is doubtful if the nurse can be made to attend to this detail, and, for ordinary use, boiling does not seem to affect the value of the whey. To the whey there may slowly be added small quantities of mutton-broth, egg-albumin, sugar, bread-jelly, or dextrinised gruel; and, when sufficient improvement has taken place, the child may be put on cream and whey mixture.

If the infant is in a state of collapse, - from constant vomiting or profuse diarrhoea, as evidenced by coldness of the extremities, cyanosis, an inelastic skin, and depressed anterior fontanelle, - white-wine whey in small quantities may tide it over the crisis. It is easily digestible, and also a stimulant; it can be given in very small quantities, and is usually retained - even by an irritable stomach when all other food is rejected.

It is prepared by adding one wineglassful of sherry to half a pint of boiling milk; this should be turned into a basin, and the whey poured off from the curd, after it has been allowed to settle to the bottom. The curd of the whey thus prepared is flocculent, and there is more fat in the alcoholic variety than in whey prepared by rennet. The whey has a marked acid reaction - due to the tartaric acid and acetic acid of the sherry.

G. Still (Lancet, Jan. 13, 1907) advises the use of cooking-sherry in the preparation of white-wine whey: for he finds that, whereas three to four ounces of ordinary sherry are required to curdle half a pint of milk, this quantity is readily curdled by two and a half ounces of cooking-sherry. It also has the advantages of reducing the quantity of alcohol (about 2.28 per cent. by weight), and also lessens the cost (drinking-sherry, 2/1 per bottle; cooking-sherry, 1/- per bottle). White-wine whey is useful as an intermediate food, after albumin-water or broth mixtures, before returning to peptonised or diluted milk mixtures. Our author considers that it is seldom advisable, at any age of infancy, to exceed two and a half ounces of white-wine whey at a feed. It is best to give it in very small quantities, repeated at short intervals.

A preparation, the main constituents of which are the rennin ferment and sugar of milk, and named PEGNIN, is sometimes useful when it is required to render the curd of milk more digestible. It was first described and used by v. Dungern (Munch. med. Woch., No. 48, 1900), and has since been advocated by several German physicians.

The preparation of milk by this method is very simple. The undiluted milk is sterilised, and allowed to cool to 104°F. One measure of Pegin (supplied with the bottle) is then added to eight ounces of milk kept at this temperature. The milk almost immediately clots into a large, but soft, curd, which is easily broken up by vigorously shaking the bottle. The curd is much softer than the ordinary casein curd, and the milk is in a more digestible form; it may be given pure, or diluted with boiled water.

Theresa Oppler (Monat. f. Kinderh., Jan., 1904, p. 530) gave this milk a thorough trial at Breslau, administering it to 222 babies, and arrived at the conclusion that the indications for it were:

- (1) When the general condition is bad after exclusive starch diet.
- (2) In gastro-intestinal disease.
- (3) In habitual vomiting.

Its use is contraindicated during the first month of life, and in diseases due to overfeeding. Children do not seem to thrive on this food, if it is given for any length of time.

The writer finds that milk prepared with Pegin is a useful temporary food: for, owing to the digestibility of the curd, it is often well borne when ordinary milk is rejected by the stomach. He uses it as an intermediate food after gastritis or gastro-enteritis, before returning to a whole-milk diet, but never keeps a patient solely upon this food for any length of time. It is also a useful food to give a child, when, according to the

parent, there is inability to digest cow's milk: for, as it is easily assimilated, the digestion improves, the confidence of the mother is restored, and there is then no difficulty in returning to an ordinary milk diet.

#### VEGETABLE AND MALT SOUPS.

In cases of acute gastro-enteritis, it is sometimes found that soups prepared from vegetable legumens and cereals will often be absorbed and nourish the child, when other foods prove useless and are rapidly ejected as lenteric motions.

It is only latterly that the writer has made use of these foods, but believes that they should prove of service in the early stages of acute gastro-enteritis, or in cases of fat indigestion or catarrhs of rachitic origin which resist other forms of treatment.

Bailey (Gaz. Héb. de Sci. Méd., June 2, 1906) gives the following recipe for a vegetable broth: Carrot, 65 grm.; potato, .5 grm.; turnip, .5 grm.; dry peas or haricot, .25 grm.; and salt to a litre of water. This should be slowly cooked and strained. When the disease abates, a slow return should be made to humanised milk or butter-milk.

Méry's soup is practically the same as that just described.

Comby's soup consists of three legumens and three cereals: it differs from Méry's in containing more phosphates and sulphates, and in being richer in hydrocarbons and vegetable albumins. He considers (Rev. Mens. des Mal. des Enf., March, 1906, p. 112) that the best results in various infantile dyspepsias are obtained by the use of food stuffs rich in hydrocarbons, in which the starch has been rendered soluble by diastase, but not converted into sugar.

Terrien's **soupe** for the preparation of a malted soup is as follows: One-third of a litre of milk, two-thirds of a litre of water, 70 - '0 grms. of rice cream, and 50 grms. of ordinary sugar. Boil for a quarter of an hour, and allow an infusion of crude malt to act on the mixture at a temperature of 80° F. It is indicated if milk is not tolerated and carbohydrate is required, as in dyspepsia and chronic gastro-enteritis, but contra-indicated in vomiting and diarrhoea. It should not be given to infants under four months of age.

Malted soup may be given for several weeks, and in the same quantities as milk, and is of value as a food after the use of vegetable decoctions.

Gregor (Deut. med. Woch., Oct. 6, 1893) speaks of the value of malt soups in the feeding of infants with gastro-intestinal affections, and says he has used it in more than 100 cases. He gained better results with this food than with Gaërtner's fat-milk preparation, and considers that, in infants over three months of age with chronic gastro-intestinal affections, malt soup should be tried and continued for several months. Children from ~~nine~~ to fifteen months, with severe rickets, he considers should be tried with this method of feeding.

In cases when milk is no longer tolerated, and in various disorders of the digestion, the writer holds that these soups should be given an extensive trial. The results obtained with malt soup are considerably better than with other artificial foods.



Case of Protracted Diarrhoea, Due to Improper  
Feeding, Recovering under Treatment  
With Vegetable Soup.

The notes of the following case illustrate the value of vegetable soups under special circumstances.

W. B., a baby aged three months, was first seen by the writer, on September 28, 1906, to be suffering from acute diarrhoea. It had been fed on the breast for two months, but latterly on condensed milk and barley-water. The mother had followed the directions on the tin, and the milk mixture was much too strong. The child's weight was then 10 lbs. 2 ozs. A reduction of condensed milk to 1 part in 24 of water cured the diarrhoea, and it was ordered a weak mixture prepared with cow's milk.

October 8.- The diarrhoea returned, - so the child was put in a mixture of equal parts of weak mutton-broth and barley-water, small quantities being given at short intervals. Weight - 9 lbs. 2 ozs. The child became progressively worse, and, though several weak mixtures, - such as egg-albumin water, - were tried, all food passed ~~through~~ the intestines undigested.

From October 15th to 27th, the child was critically ill, lying ~~with~~er comatose or semi-convulsed. The skin was dry and inelastic, the anterior fontanelle was depressed, and the temperature ranged between 100° and 102° F. The child was practically moribund.

An attempt was then made to feed it with a vegetable broth, and, as the people had no great cooking facilities, it was made as simple as possible. The broth consisted of a teaspoonful of finely-chopped carrot, turnip, lentil, barley, and sugar of milk, boiled together in a pint and a half of water slowly down to a pint; and to this was added one teaspoonful of salt, which, however, proved excessive and necessitated its reduction. At the same time the colon was thoroughly irrigated, and a small dose of castor-oil administered, even though these remedies had proved ineffectual on previous occasions. The soup was well borne and retained, the convulsions ceased, the temperature fell in a week, and the motions, from being green and slimy, began to be of a better colour and firmer consistence.

The future treatment is unimportant. White-whey was given for a time, when whey diluted with vegetable soup, passing on to whey only. An attempt was made to give a few drops of cream with the whey, but it was not tolerated by the infant. A mixture of bread-jelly (one dessertspoonful), in equal quantities of whey and water (total 8 ounces) plus sugar and a few drops of raw meat-juice, was well taken, and the child rapidly gained flesh. Peptonised milk was added in teaspoonful doses, and after a time boiled milk. The mixture that agreed best for a long time was:

Peptonised milk ..... 5 teaspoonfuls.  
Bread-jelly ..... 1 dessertspoonful.  
Sugar of milk ..... 1 teaspoonful.  
Whey ..... to 5 ounces.

Progress was slow, but uneventful. For the anaemia, a mixture, containing citrate of iron and ammonia and a glycerine extract of bone-marrow, appeared to do good.

There was some sweating of the head at night, and the child was restless. The peptonised milk was slowly replaced by ordinary cow's milk, and the strength of the mixture increased very gradually. At the end of the year (1906) the brothers had chicken-pox, but the infant did not take it, and steadily gained flesh.

During January, 1907, the child had two attacks of bronchitis, from which it recovered slowly, though there was no pyrexia. It is still anaemic, but the weather prevents it being out of doors. Any attempt to add fat to the diet is resented: the infant cannot tolerate cream or cod-liver oil.

The present condition of the child suggests slight rickets. The frontal eminences are prominent, the anterior fontanelle is large, the edges of the sutures are thickened, and there is slight beading of the ribs, thickened epiphyses of the wrists, and curvature of the tibiae. No teeth, but slobbering. The child sits up by itself during examination, and is lively. The food is now two and a half ounces of milk, and one teaspoonful of bread-jelly and sugar in five ounces of water. The milk is being gradually increased to make a mixture of two parts milk and one part water. The child is unable to digest strong milk mixtures, and cannot tolerate cream; it also does better with bread-jelly solution than without it. It is taking a mixture of the syrups of the glycerophosphates and calcium lactophosphate. At eight months of age it had one tooth.

#### BUTTERMILK.

A very useful food, - and one that seems to be increasing in favour, especially with continental pediatricists, - is buttermilk. It is not regarded altogether with favour by the American writers, who are more enthusiastic advocates of feeding by prescriptions with the elements of milk supplied in varying percentages. Nevertheless, the literature on buttermilk as a food is rapidly increasing, and there are many who report upon it in enthusiastic terms, when used for infantile dyspepsia or rickets. Buttermilk has been used by the Dutch peasants since 1770 as a food for children, but was not employed by the Dutch physicians until 1865. It was first used in Germany in 1898, and a few years later was given a trial in France.

It is usually prepared from sour cream or milk, and seldom from sweet cream. Buttermilk should be used fresh within twenty-four hours of the making of butter. As a result of centrifugalization, the casein is finely divided, and the relative proportions of the casein and the albumin are changed; the albumin being the greater, the casein is in the form of lactate of casein, which is a soft flocculent curd, and capable of easy digestion. Buttermilk has also a certain bactericidal action, and seems to inhibit the growth of intestinal bacteria. Its good effects are due to the fine division of the curd, and to the presence of lactic acid (acidity = 0.34 lactic acid).

Various authorities differ with regard to the caloric value of buttermilk; it varies between 300 C. and 450 C. per litre; while Salge and Heubner estimate it as high as 714 C. (Therapie de Gegenwart, Oct., 1901). The analysis

of buttermilk gives a low fat, and a moderate sugar, as well as a high proteid. Salge's analysis is as follows:

Fat.	Sugar.	Proteid.
$\frac{1}{2}$ - 1%	3 - 3.5%	2.5 - 2.7%

On account of the low fat percentage, buttermilk may be useful in catarrhs of the intestinal tract, especially with fermentation, in the dyspepsias of weaning, in cases of fat indigestion when fat is contraindicated, and also in cases which are unable to digest the casein of milk, which in buttermilk is more digestible, owing to the peculiar character and division of the proteid and the soft flocculent curd. With so low a percentage of fat, it would not seem to be a suitable food to use in the diet of a rachitic infant; nevertheless, buttermilk has given very good results in the treatment of this disease.

Rommel (Arch. f. Kinderh., Vol. xxxvii, p. 252) regards it as surprisingly certain therapeutic diet, but, as it affects the mineral metabolism (especially the calcium balance) if its use is prolonged, there should be an increase of fat and a diminution of the sugar to this food.

J. Grégoire (Arch. de Méd. des Enf., Feb., 1903, p. 65) advocates the use of buttermilk for infants, if breast milk is not available; and Jean Cardamatis (ibid., Feb., 1904, p. 87) concludes from his experience that prepared buttermilk is the best substitute for breast milk in cases of malnutrition and gastro-enteritis. Healthy children, he finds, thrive on buttermilk, but its most brilliant results have been obtained in epidemics of gastro-enteritis, when it proves superior to various watery or broth diets.

Despite the low fat percentage, Elie Decherf (ibid., Jan., 1905) finds it a reliable food in rickets. He writes that it is a specific and an assimilable food in gastro-enteritis, and gives "splendid results in rachitis".

The usual practice of continental pediatricists is to add some form of carbohydrate to the buttermilk. It is often referred to under the name of "babeurre", which is usually made according to the following recipe:

Add a teaspoonful of arrowroot rice or wheat flour to a litre of buttermilk, place on a slow fire, and bring the mixture to the boil, taking about twenty-five minutes to do so; during this time it is important to stir thoroughly, preferably with a wooden spoon. About 80 grammes of sugar are then added, and the whole cooled. After boiling, when standing, two layers form - the lower being yellowish and made up of clotted casein, and the upper being clear whey.

In feeding with babeurre, care must be taken that the nipple holes are sufficiently large for the curd to pass. Babeurre seems to give better results than buttermilk alone; the addition of the starch and sugar probably increases its nutritive value, and the curd is kept mechanically in a finer state of division.

It is not always possible to get a daily supply of fresh buttermilk, but, if it could be more easily obtained, it deserves to be given a more extensive trial as an



infant's food, and, if used for rickety children amongst the poor, it has the great merit of cheapness. If used for any length of time, gravity-cream should be slowly added to increase the amount of fat in the food.

#### Case Treated with Buttermilk.

The supply of fresh buttermilk in Hoylake is very irregular, and it is seldom possible to get it daily; but the notes of the following case illustrate the good results that can be obtained by cutting off a rich and assorted diet, and feeding only on "babeurre" or carefully modified milk.

Baby G., - on the breast for eight months, then fed on "anything that was going", - was first seen when thirteen months of age. The child had only cut six teeth, and its weight (with clothes) was 17 lbs.

For two months, on and off, it had suffered from diarrhoea with frequent ~~shiny~~ and offensive motions. It was very peevish and irritable, and the mother described the baby as "having no life in it". All the early signs of rickets were present: enlarged anterior fontanelle, large head, delayed dentition, rickety ~~rosary~~, curvature of the spine, enlarged epiphyses, and tumid abdomen.

The early treatment was a preliminary dose of castor-oil, and a diet of barley-water for twenty-four hours. The child was then put on "babeurre", at first in small quantities every three hours, and the amount gradually increased when the digestive disorders were corrected. On days when it was impossible to get buttermilk, resort was had to milk carefully prepared with Pegnin powder.

The first noticeable result was that the diarrhoea ceased in a very few days, and that within a week the child had one daily motion of normal colour and consistency, with no offensive odour, and no slime or mucus. The abdomen became soft, and no longer distended with flatus; the mother remarked that the child was stronger and sat up better. From being cross and irritable during the day and restless at night, it became bright and lively and a good sleeper. Before treatment its colour was dirty and anaemic, but within a fortnight the child had a return of bright healthy colour in its cheeks. The "babeurre" was continued for about twenty days, then, as the general health was good and there was no gain in weight, the diet was altered to oatmeal-jelly, and milk with a few hard baked crusts for the child to masticate against. On this diet, in rather less than three weeks, its weight rose to 18½ lbs.

On account of the extreme poverty of the parents, the child was admitted to the Children's Convalescent Home, West Kirby, where, under better hygienic conditions, open-air life, and regular diet, it is making steady progress, and looks bright and healthy.

The improvement of this case in the early stages was doubtless partly due to the cutting off of the indigestible and unsuitable food, and the feeding with small amounts at regular intervals; but the writer is of the opinion that the rapid disinfection of the intestinal canal, and the cure of the diarrhoea and digestive disorders were due in great measure to the

use of the "babeurre". With the exception of castor-oil, no drugs were given during the entire treatment of the case.

### LACTOBACILLINE.

For some years Professor Metchnikoff has shown that the use of acid milk is of great value in the treatment of various intestinal disorders set up by fermentation and putrefaction in the intestinal canal. Under his direction, a milk, treated with a culture of specially selected lactic acid bacillus, is now prepared; and it is largely used in the treatment of the various disorders of digestion which occur in infants, or in adult life. Our author first published an account of this acid milk in the "Revue Scientifique" (1904, Vol. ii, p. 103); and, in a small brochure abstracted from this report ("Quelques Remarques sur le Lait Aigri"), he gives a good description of this preparation, and shows how valuable it may be in the treatment of infantile digestive disorders of a putrefactive nature.

By the use of this milk, much larger doses of lactic acid can be introduced into the system than is possible in the form of an ordinary mixture. This acidified or lactated milk is allied to buttermilk, and is prepared by acting upon milk with special preparations of the lactic acid bacillus supplied under the trade name of Lactobacilline.

The ferment lactobacilline is prepared with pure cultures of the bacterium lactis, care being taken to exclude all useless or harmful organisms, which are often found in some abundance in such other acid milks as kephir. The lactic acid germ is selected from the Bulgarian and Eastern varieties, which have been shown by the researches of Professor Metchnikoff to be quite harmless, and can be safely introduced into the human body.

The organisms, according to Dr. Cohendy, take about a week to gain a footing in the intestines, when they convert the alkaline faecal matter into an acid medium, in which the putrefactive organisms can only flourish with difficulty.

The Lactobacilline is prepared in Paris, at the "Le Ferment" laboratory, and consists of an active ferment prepared from curdled milk after the method designed by Professor Metchnikoff. It can be obtained in the form of a powder, as a fluid, and as a paralactic broth. The powder can be obtained from the London agent, and keeps indefinitely; the fluid has to be ordered from Paris, and only keeps about three weeks. A special chamber or stove is also supplied, in which the milk can be kept at the proper temperature for the requisite number of hours; but a water-bath or an incubator will serve this purpose equally well.

The acid milk is prepared by acting upon sterilised milk with the Lactobacilline (fluid or powder containing the organism producing lactic acid), which has been previously mixed with a little cold boiled milk. The milk requires to be kept at a temperature of 100° to 104° F. for about seven hours.

The writer has found that the milk curdles best if the temperature is kept steadily at 104° F., but the

complete preparation sometimes takes ten hours. The milk forms a soft flocculent curd, which can be easily broken up with a spoon, or by vigorously shaking the bottle. Its odour is quite agreeable, and, if sweetened with sugar, the milk is pleasant to the taste.

The proportions of lactic acid in one litre of milk has been found to be 7.2 grammes, which will be equivalent to 92 minims of pure lactic acid. This analysis was made by the dispenser of the Great Ormond Street Children's Hospital (Clin. Jour., Vol. xxix, p. 147).

The acid milk has also been analysed by M. Fouard, at the Pasteur Institute, who found that it contained 10 grammes of lactic acid to the litre. Furthermore, he states that a notable quantity of the casein (about 33 per cent.) has been rendered soluble by the fermentation rendering the albuminoid matter as easy of digestion as in the case of kephir. The phosphate of lime was also dissolved during fermentation, in the proportion of 68 per cent. (Elie Metchnikoff, - loc. cit., p. 28).

M. Brudzinsky has employed the lactic acid preparation in certain intestinal disorders of nurslings; and Tissier (Ann. de l'Inst. Pasteur, 1905, p. 295) has employed it largely in the treatment of diseases of the digestive system both in children and adults.

F. Batten (Clin. Jour., Vol. xxix, p. 149) has treated twenty-one infants with lactated milk, and found that children who were unable to digest any other form of milk could often take and retain it after preparation with Lactobacilline. He regards it as a remedy of particular value in chronic diarrhoea and colitis, and proposes to give it an extensive trial in the treatment of the offensive diarrhoeas of rickety children.

It would seem that treatment with milk prepared with Lactobacilline opens up a more rational and thorough method for the disinfection of the intestinal tract, and may eventually displace the unsatisfactory treatment with the so-called intestinal antiseptics, as salol, resorcin, naphthalin, and similar drugs at present used for this purpose. These remedies are never very certain, and are often very ineffective in their action.

It might be raised as a possible objection that it would be unwise to administer lactic acid to a rickety child, but, as present-day pathology does not support the theory that lactic acid is present in the blood of a rachitic person, this cannot be regarded as a contraindication to the use of this valuable food. Its power of correcting fermentation due to microbic infection should make Lactobacilline a very useful remedy for all cases of rickets in which gastro-intestinal disturbance is a marked feature.

#### Case of Rickets Treated with Lactobacilline.

It is only within the present year that the writer has been able to test the value of milk prepared with the Lactobacilline.

The time occupied in its preparation, and the attention required while the milk is curdling necessitates, in many instances, constant supervision; and it is often advisable to personally prepare the food, and distribute it ready made - in bulk, or in soxhlet



bottles containing sufficient for each meal. The risk of failure to curdle is greatly minimised if the milk is kept at a steady temperature of 104° for ten hours. If overcooked, a small amount of fluid resembling whey settles on the top of the curd, and this should be poured off before using the milk. As the fluid preparation only keeps three weeks and has to be obtained from Paris, the use of the powder is advisable in general practice; and the writer has found it, in nearly every case, quite satisfactory, as only occasionally does the milk fail to clot.

Up to the time of penning these lines, the writer has only tested the milk on one case, but the result obtained was so striking that it encourages him to give Lactobacilline an extended trial, when suitable cases come to hand; and during the summer months it should prove useful in the treatment of the later stages of summer diarrhoeas.

Case K. I.— This little girl had come out of a workhouse hospital, and, though fully two and a half years of age, weighed only fourteen pounds.

She had all her teeth, but the upper incisors were decayed down to the gums, the anterior fontanelle was not completely closed, the edges of the sutures were thickened, and the head was of a typical rachitic shape. Other signs present were a deformed chest with a well-marked rickety rosary, Harrison's groove, enlarged epiphyses, and marked kyphosis of the spine. The child was unable to stand, and, if placed upon the ground, its legs gave way beneath it; but there was no true paralysis. The abdomen was enormously distended, and as tense as drum. There was no dilatation of the stomach, and the spleen and liver were not enlarged. The child had constant diarrhoea, passing frequent stools, very offensive in odour, and full of slime and mucus. There were signs of previous broncho-pneumonia in the left lung. The skin had a dirty unhealthy colour, and it was inelastic and ill-nourished. All the muscles of the body were flabby and wasted.

At the crèche the child had been fed with plenty of food, Virol and cream, but, as the patient was manifestly getting worse, the writer was asked to see it. The general condition of the child seemed very grave, but, as the offensive diarrhoea was a marked symptom, it seemed a suitable case in which to test the power of the lactic acid bacillus on the intestinal putrefaction: it was therefore decided to give the lactated milk a trial.

The milk was prepared by the writer, and, during the first few days, given diluted one-half with water, and sweetened with a little sugar. For the first two days two and a half ounces of this mixture were given every three hours, but afterwards it was taken pure and in larger amounts. The child took the preparation well, and preferred it to ordinary milk.

Though intestinal fermentation had been in active progress for some time, the beneficial effects of the lactic acid were soon apparent: for, within three days, the abdomen became soft and flaccid, and the writer was able to palpate it with the greatest ease. No

enlarged glands could be felt, though the child had every appearance of having contracted tuberculosis. The stools became normal in colour and consistence, and there was complete disappearance of the slime and the offensive odour.

This treatment was continued for twenty-one days, after which time the child had made very good progress; it was able to sit up, and began to take notice of its surroundings. Its general condition improved to a remarkable extent, and the visitors to the crèche all commented on the child's bright and changed appearance. On return to ordinary food, the child was given oatmeal-jelly, raw meat-juice, or pulped beef and crusts - all of which were taken without discomfort or indigestion.

The home conditions of this child were pitiable: the father had deserted the mother, who was obliged to work in order to support a family of little children, - so that, unless at the crèche, the child did not receive proper attention, and progress was hindered to some extent.

Three weeks later, it contracted a broncho-pneumonia, and was removed to the Children's Convalescent Home, West Kirby, of which it is still an inmate.

#### KEPHIR.

A food, very similar to the milk that has been prepared by acting upon it with lactic acid bacillus, is known as Kephir, which has been used for ages by the Caucasian tribes, although the ferment was only first investigated, in 1879, by Russian and German physicians.

Kephir is a modification of cow's or goat's milk, resulting from a process of fermentation produced by the action of micro-organisms. The kephir ferment consists of three kinds of organisms, - the bacillus *Caucasius*, *saccharomyces mycoderma*, and the bacillus *lactis*, - which are found in the dried masses of the ferment, the small kephir beans, and are held together by a gelatinous substance. The mass of micro-organisms is procured from the dirty skim-milk sacks of an uncivilised and filthy people (Barry, - Quoted by Cautley, *The Feeding of Infants*).

Kephir takes about twenty hours to prepare, and is usually not drunk until the second day. Two layers are formed. The lower one is milky and translucent, and the upper contains the casein in the form of white flakes. It contains very little carbonic acid or alcohol. On analysis it is seen to be composed of:

Proteid.	Fat.	Sugar.	Lactic Acid.	Alcohol.
3.8	2.0	2.0	0.9	0.8

Kephir is said to be a tonic and a stimulant, and, owing to the casein being converted into the soluble albumins, is more easily digested than cow's milk. For young infants kephir requires to be diluted, but, at the age of six weeks, it can be given pure. Koumiss is sometimes used instead of kephir: it is an alcoholic drink prepared from mare's or ass's milk by a similar fermentation of the milk-sugar.

Unless its special value lies in being a stimulant, and possibly also as an antiseptic, kephir does not appear to possess any advantages over buttermilk,

"babeurre", or milk prepared by Lactobacilline. It is difficult and expensive to obtain, and its dirty source does not tempt one to use the preparation in the feeding of infants.

Metchnikoff, however, recommends kephir as a good nutritive, and as an intestinal antiseptic.

J. Roxirosa has witnessed excellent results follow the use of kephir, at the Children's Hospital at Barcelona, in tuberculous and rickety children; and Feig recommends it in chronic gastro-intestinal catarrh and debility (Merck's Reports, 1905, p. 122). Both these authors point out that the use of kephir always has the effect of improving the body weight.

Nevertheless, the results are so similar to those more easily obtained by "babeurre" and lactated milk, that there seems no good reason why kephir should replace these dietetic remedies in pediatric practice.

Amongst the poor, or in the case of persons who are careless in the preparation of whey or similar foods, the use of partially or wholly DEXTRINISED GRUELS will be useful for infants, who, for the time being, are intollerant of milk in any form.

The simplest, and at the same time the cheapest, of these foods is the "Bread Jelly" of Cheadle, and it is very easily prepared in the home kitchen. A round of bread (preferably of seconds flour) should be well soaked over night, in order to rid it of the lactic acid. It is then slowly boiled in a pint of water for an hour and a half, in order to convert the starch into dextrin and grape sugar. It is strained through a sieve, and, when cold, forms a white jelly. As it readily sours, it should be prepared twice a day. It is useful vehicle in which to give meat-juice or cream, or it may be added to the vegetable or malted broths.

When used, it is diluted with boiled water to make a food the consistence of thin cream (one tablespoonful to eight ounces of water) and a little sugar added. Thus diluted, the analysis is:

Proteid.	Fat.	Carbohydrate.
0.74	0.13	4.15

Small quantities of boiled or peptonised milk are slowly added, or, if required, raw meat-juice and cream. A mixture of bread-jelly solution -  $4\frac{1}{2}$  parts (five tablespoonfuls), raw meat-juice -  $1\frac{1}{2}$  parts (6 teaspoonfuls), cream -  $\frac{1}{2}$  part (2 teaspoonfuls) has the following percentage:

Proteid.	Fat.	Carbohydrate.
2.71	3.63	2.93

The deficiency in carbohydrates can be remedied by the addition of sugar.

The writer has often found this bread-jelly of the greatest service, and considers that it should be more widely used. The jelly satisfies the mother that the child is having a food, it is easily prepared at home, and it serves to impress on her mind the needlessness and the expense of all the patent foods.

Dextrinised gruels are also very useful as temporary foods, or as permanent diluents of the milk. This gruel is prepared by beating up one or two tablespoonfuls of barley, or double this amount of rolled oats, into



a paste with cold water, then adding a quart of boiling water, and cooking for at least fifteen minutes. When the gruel has cooled, add one teaspoonful of a preparation of malt, and allow to stand, when rapid thinning of the solution takes place. The writer finds a temperature of 100° to 105° F. the most certain, as thinning is not so rapid or complete below this. Virol can occasionally be used in the place of ordinary malt-extract.

Dwight Chapin (Infant Feeding, p. 236) estimates that dextrinised gruel will contain from 0.3 to 0.5 per cent. of proteid, and 2 - 4 per cent. of soluble carbohydrate, depending upon whether one or two tablespoonfuls of cereal flour are used to the quart of water.

In the writer's experience, dextrinised gruel with milk is not always well borne under the age of two or three months; and during this period he prefers to use boiled water or whey as the diluent. As with bread-jelly food, raw meat-juice or cream may be added to the dextrinised gruels.

The white of an EGG, with one or two teaspoonfuls of sugar and eight ounces of dextrinised gruel, is often a better food than ordinary albumin-water. Its composition is: Proteid - 2 per cent., and carbohydrate - 4 to 7 per cent. (Chapin). If fat is required, and cream is not well borne, the yolk of an egg may be added to eight ounces of dextrinised gruel and sugar, as before. The composition will be:

Fat.	Proteid.	Carbohydrate.
1.5%	1.5%	4 - 7%

The egg mixture may be heated up to 150° F. without coagulation taking place, and may therefore be given warm when it is considered necessary.

These various foods have been mentioned at some length: for they may be found very useful when the diet of a rickety infant, with feeble digestion, has to be arranged; and one or other may serve to nourish the child, until it is strong enough to digest and assimilate some modification of cow's milk. If the physician has a knowledge of these various foods, he will seldom find it necessary to have recourse to patent foods; and the mother will learn to rely upon the resources of her kitchen, and will no longer litter her nursery with numerous tins of preparations, which should be regarded as poisons to all infants during the first year of life.

#### MILK MIXTURES.

Having steered the rickety infant safely through the quicksands and shoals of dyspepsia, gastro-enteritis, and the various catarrhs of its alimentary tract, it can now be fed on milk mixtures carefully modified and adapted to its age, weight, and special idiosyncrasies.

Due regard must be observed that a definite ratio is kept between the proteid, fat, and carbohydrates: for any disturbance of the balance by excess of one element may interfere with the proper assimilation of the rest. Any attempt to arrange the food with a high percentage of fat in the diet of an infant, simply because it is suffering from rickets, is much to be deprecated.

At the present time the student of the subject of infant feeding is bewildered with the variety of

methods suggested by the many works on the subject now available; and the numerous charts for the ready calculation of percentage milk mixtures can seldom be memorised, so as to be useful in everyday practice. Frequently, even if he is able to work out a definite formula, his little patient rises superior to any modifications it ought to take (on paper), and digests and thrives on a mixture that defies all recognised canons and laws. It is well to think in percentages, but not to make a fetish of them. In infant feeding, every child is a law unto itself: therefore, it is necessary that the physician should study the individual, and not the text-book.

It may be necessary, for a time after a diet of whey, buttermilk, or gruels, to combine with one of them a small quantity of peptonised milk, but this course should not be long continued, as it is important that the stomach should be accustomed to the act of digestion, and trained to exert its functional powers, in order that there may be no interference with, or retardation of, its proper development. It is in every way advisable to stimulate the healthy secretion of the digestive juices: for it is by their chemical action upon the milk that combinations are formed, which are gradually retained for longer periods and dealt with in the stomach, and not quickly passed on, as in the early days of life, from that organ into the intestines to be digested by the pancreatic juices. It is by this gradual method that the stomach prepares itself for the digestion of solid food.

At this period CONDENSED MILK, or one of the DRIED PREPARATIONS OF MILK may be of temporary service, as the curd in these forms of milk is often more finely divided than in raw cow's milk.

It is necessary to be sure that the infant is being fed with a condensed milk of a reliable brand containing cream, and not one of the many worthless preparations, made from skim-milk, which at present flood the market. The milk should also be freely diluted, and, if given to a small infant or a child with feeble digestion, 1 in 24 will be sufficiently strong until the capacity of the stomach has been tested by the food.

The dried milk should be replaced by fresh milk at the earliest possible opportunity, and the mother warned of the danger of long continuance with these sterilised foods.

If the infant is still unable to digest casein, whey, and cream mixtures may be tried for a time; but, as soon as possible, an attempt must be made to persuade the stomach to digest a diet that contains some casein proteids.

In WHEY CREAM MIXTURES, a digestible proteid, in the form of lactalbumin, is supplied; and the indigestible proteid is almost entirely eliminated, together with a definite proportion of fat. By keeping the caseinogen at a minimum and the lactalbumin at a maximum, it is possible to obtain  $\frac{1}{2}$  a moderately strong food, and thus derive better results than by other methods in which casein is present and interferes with the digestion of the other elements. It is convenient to use a 20 per cent. cream, which can be obtained from the top five

ounces of a quart of milk that has been allowed to stand for three or four hours.

### Whey Cream Mixtures.

				Fat.	Sugar.	Proteid.
1.	20 ounces of Whey	+ 1 oz. of Cream	=	1	5	0.90
2.	"	+ $1\frac{1}{2}$	"	1.50	5	1.00
3.	"	+ 2	"	2.00	5	1.10
4.	"	+ $2\frac{1}{2}$	"	2.40	5	1.15
5.	"	+ 3	"	2.75	5	1.20
6.	"	+ $3\frac{1}{2}$	"	3.15	5	1.25
7.	"	+ 4	"	3.50	5	1.30

White of egg or milk-sugar may be added, if required.

It is advisable to use only whey-cream mixtures for temporary feeding, and to try at an early date to reduce the cream by using a larger quantity of the top milk, or by adding plain milk to the bottles.

### MILK MODIFICATIONS.

Rickets is a disease largely found amongst the poor, - so that, unless milk laboratories are available, all modifications of the food should be of the simplest description. But, whenever possible and until people have learnt the necessity of obtaining clean milk and of keeping it free from contamination, it is advisable to endeavour to feed infants on milk specially prepared and modified at a dispensary. This, at present, is only possible in fairly large towns, and it is therefore necessary to be able to modify the milk at home. There is a choice of several methods - viz.:

(1) Simple dilution of milk with water or cereal gruel and an alkali.

(2) Milk modified with citrate of soda.

(3) Humanised milks.

(4) Top-milk mixtures.

(5) Undiluted milk (French school).

### CEREAL GRUELS.

Cow's milk is often diluted with a thin cereal gruel, usually prepared from barley or oatmeal. The action of the gruel is mechanical: for it ~~breaks~~<sup>breaks up</sup> the casein into smaller curds, and prevents the formation of tough and indigestible masses. The gastric juice more readily penetrates into the curds, and they therefore remain longer in the stomach, the act of digestion is better performed, and growth and development of the organ stimulated.

If the gruels are dextrinised, the salivary and pancreatic juices are aided in their function of converting starches into sugar, and assimilation takes place more rapidly. Barley, rice, or oatmeal may be used - the latter being often preferred if the infant has symptoms of constipation. Some of the patent foods are convenient to keep for the manufacture of gruels; but they should be used very sparingly, and not in the proportions stated on the tins. Some infants do better on milk diluted with a thin gruel, but others seem ~~unable~~ to digest the smallest quantity of starch, suffering immediately from flatulence, colic, and frothy stools, and are more comfortable if the milk is diluted with plain water. Even dextrinised gruels are badly borne during the first months of life.



Jacobi (Therapeutics of Infancy, p.29), in his teaching, for many years has advocated the use of gruels, and considers that the substitution of cows milk or of sterilised cow's milk for woman's milk, as an exclusive food, is a mistake; and that experience teaches that digestive disorders - such as constipation, diarrhoea, or rachitis - are frequently produced by its persistent use. He quotes Heubner as a convert to his views. For this authority has found that young infants do better on a dilution of milk with a thin rice decoction than with mere milk-sugar solution. Jacobi is of the opinion that, before long, it will be a generally-accepted axiom that cereals must be given to make teeth and tissues generally, when milk food alone does not suffice for their development.

G. Still holds a contrary view: for his own experience is that a small amount of starch (1 - 2 per cent.) - such as is present in barley-water - is often harmful.

An even greater danger is the use of patent foods to increase the digestibility of the milk, and modify the curd: for they are nearly always used in too large an amount, - so that they are in themselves dangerous, and also interfere with the proper assimilation of the fat.

The use of a gruel is a source of great satisfaction to the mother; she feels that the child is really being fed, and appears to regard the barley as the principal source of nourishment. If a gruel is used, precise directions must be given for its preparation: otherwise it will be administered in too strong a solution.

A short time ago, the writer was interrogating a mother on the way she was feeding her infant, then four and a half months old. She had only one breast, - so that a neighbour advised her to give barley-water. For some reason that she did not explain, the child was fed by day on barley-water, and received the breast only at night. Her method of making barley-water was original. Half a pound of barley was put into a two-pound jar filled with water, and allowed to simmer down to half this amount. Of this mixture she gave the child half a feeding bottleful every two hours. She declared that the child had no pain, and was thriving on this food.

#### Addition of Lime-Water or Bicarbonate of Soda to Milk.

In order to make cow's milk more nearly approach maternal milk, it has been customary to add an alkali, usually lime-water or bicarbonate of soda, when using it as an infant's food. This was partly done because human milk was always supposed to be alkaline in reaction, but it has lately been shown that it is faintly acid to phenolphthalein. But, apart from their alkaline reaction, both lime-water and bicarbonate of soda have a distinct action on the curd of milk.

Lime-water renders the curd of milk more flocculent, - so that it is acted upon more readily by the digestive juices. As an alkali, it retards the curdling action of the rennet ferment on the casein, and prevents the rapid formation of tough curds. This action depends largely upon the amount of lime-water present in the milk: for the rennet cannot act until the alkali is

neutralised by acid. The amount added to milk mixtures is usually 5 per cent.

Bicarbonate of soda acts in a different manner to lime-water: for it combines with the acid in the stomach, forming carbonic acid gas; and this penetrates the curd, and makes it more porous. It is a more powerful antacid than lime-water, and it is therefore able to delay the action of the rennet ferment on milk, and retards the curdling process. The amount added is usually one or two grains to each ounce of milk.

#### HUMANISED MILKS.

This term is usually employed to imdicate preparations of milk modified in composition to resemble maternal milk. It is advisable to avoid, as far as possible, the preparations sold under this fictitious and misleading name; they may be perfectly safe and reliable, but often are not quite fresh, and, if sent any distance by rail, the fat is so much shaken that it is often converted into butter.

An imitation of humanised milk is easily prepared at home. For this purpose, allow the milk to stand for three or four hours, and remove all the cream. Divide the milk into two portions, and convert one-half into whey. add cream, milk, and whey together; and a food is obtained with all the fat, but only half the casein of cow's milk and the soluble proteids.

Dilution of milk one-half with whey, and the addition of bicarbonate of soda, is recommended by Monti as the nearest approach to human milk. Five grammes of sodium bicarbonate alkalinises the milk sufficiently; or only four grammes may be necessary, if whey is used and not water.

Children may do well on humanised milk for a time, but it is advisable to discontinue the use of such mixtures after a few months: otherwise the muscles lose their firmness, and there is some failure of nutrition.

#### MODIFICATION OF MILK WITH CITRATE OF SODA.

In 1904, F. J. Poynton first used a solution of citrate of soda, in order to render the curd of cow's milk more digestible. It was originally suggested by Dr. A. E. Wright (Lancet, 1893).

The chemical action of citrate of soda on milk is not yet fully understood, but the result seems to be some combination between sodium citrate and calcium casein. The casein of the milk is acid, and in the process of curdling combines with the casein salts to produce large tough curds.

According to F. Poynton (Brit. Med. Jour., Oct. 21, 1906, p. 1021), soda is added to milk and it then combines with the caseinogen, and produces a sodium compound of a lower molecular weight, and lesser density, than the calcium compound. The calcium salts combine with the citric acid to form calcium citrate, which is then absorbed into the system.

The great advantage of adding citrate of soda to cow's milk lies in the fact that there is less need of dilution, with possible underfeeding of the infant: for the cow's milk can then be used in a more concentrated form.

E. Ausset (La Ped. Prat., April, 1905) has had excellent results from milk prepared with citrate of soda,

when given to infants who were unable to digest cow's milk prepared in other ways. In all cases vomiting, when present, rapidly ceased, and gastric tolerance of milk was soon established.

R. Abinder (La Clin. Infant., Aug. & Sept., 1905, pp. 487-555) found that the addition of citrate of soda did not modify the coagulation of milk, except in the presence of gastric juice. This writer does not agree with Paynter and Wright, who state that the anti-coagulation action is due to the precipitation of calcium salts; for her experience is that citrate of soda dissolves them. Abinder believes that this salt acts by suspending the lime in such a way that it cannot exert its influence by promoting the coagulation of the casein, as the salts of lime are not found in the coagulation mass. The addition of citrate of soda undoubtedly makes the curd easier of digestion, and can be used in artificial feeding with cow's milk and the supplement breast-feeding.

H. Shaw (Arch. Ped., 1906, p. 162) found that citrate of soda had no effect on acetic-acid curdling, but markedly delayed rennet-curdling, and caused the formation of fine soft curds.

Dwight Chapin is of the opinion that, in using citrate of soda or other chemicals, the immediate and remote effects should be borne in mind. So far, we can only tell how the drug acts on the milk; and he considers it wiser to interfere chemically with the milk as little as possible, with reference to the good of the child. Citrate of soda inhibits the action of the rennet ferment, and throws the digestion of the milk out of the stomach into the intestines; therefore, its addition may be useful in a certain class of cases. The same writer (loc. cit., Jan., 1907, p. 11) is an advocate for more precise terms for infant feeding - especially when describing the various modifications of casein at present classified under the one name. He suggests the following variations:

Simple diluted milk = Normal calcium casein.

Milk and lime-water = Basic calcium casein.

Milk and bicarbonate of soda = Basic calcium casein and antacid.

Milk and citrate of soda = Sodium casein.

Buttermilk = Casein lactate.

These casein compounds have different digestive properties; and it is therefore important to know more than merely their percentage compositions, as they all differ in their behaviour in the stomach.

Citrate of soda is undoubtedly a great addition to the means we have for modifying cow's milk, and should always be given a trial in cases where the milk is found to disagree, or there is pronounced difficulty in the digestion of the curd. In cases of gastric disturbance, it may be found useful in lightening the labours of this organ by passing the milk more rapidly into the intestine. It is usually prescribed in the dose of a grain in a teaspoonful of water to each ounce of milk, and, if dispensed in large quantities, a drop or two of chloroform should be added to the solution to prevent any mould growing in it.



The writer has not yet used citrate of soda in the treatment of rickets, but it should prove of service when it is desired to push a child more rapidly on to strong milk mixtures.

#### TOP-MILK MIXTURES.

Top-milk mixtures supply a useful method of feeding, when it is desirable to increase the fats at a greater rate than the proteids. All calculations are based upon the assumption that cow's milk usually contains 4 per cent. of fat. If the parent is too ignorant to carry out the simple instructions, it is safer to prescribe whole milk diluted with various proportions of water.

The advantage of using top-milk lies in the fact that there is no necessity for the addition of extra fat, and it therefore prevents the possibility of contamination of fresh milk with cream that may be old or stale, or containing too high a percentage of fat. All the elements are ready present in useful proportions in a good top-milk.

The disadvantage of top-milk feeding is that, if there is any excess of fat, it crowds out the proteid element, and the richer the cream the lower the amount of the nitrogenous constituents. For example, a cream of 20 per cent. fat has 3 per cent. proteids; and, with 40 per cent. fat, the proteids are 2.25. Care must be taken that a child does not get an excess of fat: for, if in excess, it may coat over the curds, and thus prevent the action of the gastric juice upon them, and so that undigested masses are passed into the intestines.

Various proportions of fat and proteid are obtained by using the upper third, the upper half, or the total quantity of a milk containing 4 per cent. fat:

(1) Upper Third.

Fat is 3 times proteid - 10 per cent. Fat.

(2) Upper Half.

Fat is twice the proteids - 7 " " "

(3) Whole Milk.

Fat and proteid are equal - 4 " " "

#### Ten Per Cent. Fat.

For all mixtures, the milk is allowed to stand for four hours until the cream has risen, and then the proportion of top-milk required is removed. For ten per cent. fat, only the upper third is required. The milk not needed may be siphoned off, or drawn off by a tap in the lower part of the vessel.

The Lupa Humaniser has a convenient glass tube and cork for this purpose; and still more convenient is the Chapin Dipper. This is a small aluminium cup, with a long handle holding exactly one ounce, and it can also be used as a measure for the milk-sugar. The writer is not aware whether it is made in England or not; but it is very cheap, and can be easily procured from New York. It is an accurate instrument for measuring small quantities of top-milk. When 10 per cent. fat and 3 per cent. proteids is required, it is necessary to remove the upper third of the milk. Various amounts of this are diluted as required with a 5 per cent. solution of lactose (1 oz. in 20 ozs.), and a 5 per cent. lime-water (1 oz. in 20 ozs.). It is advisable to freshly prepare these

diluents. In infancy, or in cases of rickets with feeble digestion, it is best to begin with very weak mixtures - for example:

Top-milk	-	2 ounces.
Lactose	-	1 ounce.
Lime-water	-	1 "
Boiled water	to	20 ounces.

The proportion of milk may be increased ounce by ounce, until, - by three or four months, or when digestion is stronger, - it is six or seven ounces of top-milk, with the lactose and lime-water kept as before and water added to the twenty ounces.

Holt gives a useful rule that the percentage of fat is always exactly one-half the number of ounces of the 10 per cent. milk present in a twenty-ounce mixture - e. g., three ounces top-milk in twenty ounces = 1.5 per cent. fat. The proteids still are calculated as one-third of the fat in all these formulas:

	I	II	III	IV	V
Ten per cent. Milk .....	2oz.	3oz.	4oz.	5oz.	6oz.
Lactose .....	1oz.	1oz.	1oz.	1oz.	1oz.
Lime-Water .....	1oz.	1oz.	1oz.	1oz.	1oz.
Boiled Water .....	17oz.	16oz.	15oz.	14oz.	13oz.
	Fat.	Sugar.		Proteids.	
I	1.00	5.50		0.33	
II	1.50	6.00		0.50	
III	2.00	6.00		0.66	
IV	2.50	6.00		0.80	
V	3.00	6.50		1.00	

If there should be inability to follow these directions, as may happen in the homes of the poor, one part of milk may be given with three parts of water, and a small teaspoonful of milk-sugar; and, if possible, to every three ounces of mixture should be added also a teaspoonful of cream. Slow increase can be made to milk one part, water two parts, lactose one teaspoonful, and two and a half teaspoonfuls of cream to every four ounces of the mixture.

#### Seven Per Cent. Fat.

In the middle period of infancy (fourth to the tenth month), or when the digestion can manage stronger foods, the proportion of fat should be twice that of the proteid. To obtain this, the top half of milk, which has stood for four hours as before, is removed for use. It contains 7 per cent. of fat, and 3.5 per cent. of proteids. The ratio between fat and proteid now corresponds to breast milk of a rich nature. This mixture can also be made by using one part of a 16 per cent. cream, and three parts of ordinary milk. The percentage of fat is now  $\frac{7}{20}$ th (about  $\frac{1}{3}$  + 0.15) the number of ounces in a twenty-ounce mixture. To get definite 16 per cent. cream, it is necessary to leave the evening milk to stand for twelve hours in a cool place. If properly covered, there is no danger: for it has been noted that, in clean milk, the bacteria usually diminish during this period.

It is advisable at the end of the third or fourth month to begin with:

Top Fat.  
 Top half milk ..... 7 ounces.  
 Lactose ..... 1 ounce.  
 Lime-water ..... 1 "  
 Boiled water ..... 4 to 20 ounces.

Increase the milk ounce by ounce, until - at the end of the ninth or tenth month - the child is taking ten ounces of milk in twenty ounces of food, slowly adding gruels of various consistencies; but, as starch is introduced into the food, the quantity of sugar should be diminished.

	I	II	III	IV	V
Top-Milk ...	7 ozs.	8 ozs.	9 ozs.	10 ozs.	11 ozs.
Lactose ....	1 "	1 "	1 "	$\frac{3}{4}$ "	$\frac{1}{4}$ "
Lime-Water .	1 oz.	1 oz.	1 oz.	1 oz.	1 oz.
Boiled Water	12 ozs.	11 ozs.	10 ozs.	5 ozs.	3 ozs.
Barley )					
or ) Gruel	0 "	0 "	0 "	4 "	5 "
Oatmeal )					

	Fat.	Sugar.	Proteids.
I	2.50	6.50	1.25
II	2.80	6.50	1.40
III	3.15	7.00	1.55
IV	3.50	6.00	2.00
V	4.00	6.50	2.00

If top-milk is not used, these mixtures should be made in the following manner:

Milk and water equal parts, or slight excess of water. Cream 3 teaspoonfuls, to be added to every four ounces.

The milk is slowly increased, until, at the end of nine or ten months, the child is taking: Milk and water equal parts, cream four teaspoonfuls, lactose one and a half teaspoonfuls to every five ounces of food. To this mixture gruel or bread-jelly can be slowly added.

In treating a case of rickets, the ordinary mixture of half milk and half water often proves sufficiently strong for some little time, and the amount of proteid, if no starchy food is added and the amount of proteid (1.5%) is as much as the child can comfortably manage; but the mixture is low in fat (2%) and carbohydrates (2.5%). Two parts of milk and one of water increase the proteids, but do not raise the fats and sugars sufficiently:

Proteid	Fat.	Sugar.
2.2%	2.6%	3.3%

Cheadle (Artificial Feeding, p. 54) finds that two parts of milk and one part of water fulfil the essential conditions if  $1\frac{2}{5}$  per cent. of fat, which is  $2\frac{4}{5}$  of 50 percent. cream, or fifteen drops to the ounce; and  $3\frac{1}{2}$  per cent. of sugar, or eighteen grains to the ounce, are added.

#### Percentage Feeding.

Mention may be made here of the system of percentage feeding much in vogue in America, and brought to a stage of great perfection by T. M. Rotch. It is very fully described in his work on "Pediatrics".

The principle of the method is to write out a prescription, with definite percentages of proteid, fat, and sugar; and to have all feeds made up at a milk laboratory, or by dairy companies who are able to undertake this kind of work. The food is usually delivered in bottles, each containing enough for one feed.



It is seldom that percentage feeding need be employed, especially in rickets; and it is in many ways preferable to trust to home modification of the milk, and insist that the mother should be responsible for the proper preparation of her infant's food. It is also doubtful if infants do well on a diet that is always of the same composition. Human milk often varies, and the stomach of the child should ~~be~~ capable of dealing with the different proportions of the elements, provided the limit of safety is not exceeded. Any modification of the casein can be overcome at home by using, for a time, the whey-cream mixtures.

Cautley characterises this method of feeding as the "toujours perdrix" diet, and regards the rigid adherence to this feeding at every meal as unnecessary: for it treats the infant as a machine, and its stomach as a test-tube.

This method is not advocated in the feeding of rickety children: for in this disease it is most desirable that the feeding should be supervised by the physician, and that the responsibility for the proper preparation of the food should fall upon the mother or the nurse, and not be entrusted to a milk laboratory or a dairy company.

The home modification of milk, in its most simple forms, is to be preferred, in treating a case of rickets, to laboratory percentage feeding, except in rare instances. The bogie of the percentage composition of the food has for a long time overshadowed more important requirements of a perfect artificial food. In all probability, the caloric value of a food is of more importance to the nutrition of an infant than the exact percentages of its different ingredients. By estimating the dietetic requirements of the infant on these broader lines, its nutrition could be more ~~certainly~~ determined, dyspepsia and overfeeding avoided, and the whole subject of infant feeding established on a more scientific basis. Top-milk mixtures have many advantages for infant feeding, and especially is this so in the treatment of cases of rickets, when it is advisable to watch closely the percentage of fat and proteid in the food.

Top-milk is safe, provided the milk is fresh and obtained from a reliable source; the method is simple, the percentages can be varied with ease, and the mixtures prepared quite easily by the nurse or mother. It is an easier and more flexible method to handle than the use of cream and whey mixtures: for it is not always possible to obtain cream of exact percentage. Furthermore, gravity-cream is preferable to centrifugal cream, which, in addition to a variable composition, must be added to the milk, which, if stale, may introduce poison into a previously clean food. The method can be used equally in town or country, in mansion or cottage; and the simple rules for making the modifications can be soon mastered by any mother or nurse of ordinary intelligence. It also does not increase the cost of the food, and, as the poor are frequently unable to afford any extra supply of cream, this is a great point in its favour.

A quart bottle, a glass measure, and a dipper constitute the entire outfit necessary for use in the nursery, and all can be kept easily clean. It is therefore

a cheap process, and is a simple method of getting accurate percentages, and a fairly constant relationship between the fats and proteids. The only precautions necessary are that the milk should be bottled as soon after milking as possible, and that it should be kept on ice, or in a cold bath, to inhibit bacterial growth.

The writer has a preference for Chapin's dipper, which holds exactly an ounce. It is made of aluminium, easily kept clean, and with it the person entrusted with the modification of the food can take increasing and exact quantities of the top-milk food as required. Mothers can soon be taught to use the dipper; and the gradual increase of the added milk, with all the cream, affords them visible and encouraging evidence that the infant gradually receives an increasing amount of a strong mixture; and they are more satisfied that the food is sufficient than they can be when only haphazard mixtures of milk, diluted with water in varying proportions, are being used.

Top-milk mixtures should be used, whenever possible, in the feeding of rickets, or in difficult cases of malnutrition requiring careful modifications.

#### Undiluted Milk.

France has been the scene of many revolutions in which kings have been dethroned, emperors deposed, and a democratic government set up in their stead. At the present day, in a more peaceful manner, the methods adopted for the feeding of infants bid fair to cause almost a revolution of our preconceived notions, with regard to the use of undiluted milk as a food for young infants. In iconoclastic fashion, they destroy the time-honoured illusion that an infant is unable to digest cow's milk, unless it is diluted and modified until its percentage composition approximates to that of maternal milk. It is now more fully recognised that we ~~cannot transform~~, by any dilution or modification, cow's milk into mother's milk, and that the best results may be obtained by interfering as little as possible with the food we provide for the infant. The milk must be kept from external contamination, from the moment it leaves the cow, until its consumption by the infant; and, unless there is every assurance that this has been done, all toxic products must be destroyed by boiling before it can be used as a food for the child.

For some years French physicians, - notably Budin, Variot, and Comby, - have obtained excellent results by feeding infants on small quantities of sterilised undiluted milk. The labours of Professor Budin are fully recorded in his lectures, lately translated into English by Dr. Maloney; and this work, entitled "The Nursling", illustrated by graphic and instructive charts, should be studied by every physician, who is interested in the feeding and the welfare of the infant.

The keynote of Professor Budin's teaching is the avoidance of overfeeding: for from this evil arise all the digestive disorders of infancy - whether the food be given diluted, undiluted, or in some modified form. He emphasises the fact that sterilised milk must always be vastly inferior to breast-feeding; but, by supplementing

it to a poor supply of mother's milk, he is often able to get excellent results, the child later thriving well on sterilised milk alone. Budin gives three cardinal laws:

- (1) Give milk of good quality.
- (2) Give milk in correct quantities, neither too much or too little.
- (3) Sterilise all milk.

He distributes the milk in small bottles, each containing sufficient for one feed; but Variot prefers to give the milk in large bottles, together with a large graduated measure to be used by the mother.

Curgenven (Brit. Med. Jour., April, 1905, p. 969) has pointed out that boiled cow's milk is more digestible than fresh milk; and Chavane also shows that sterilisation prevents the formation of large curds, and that the casein particles are small, and resemble closely in size those of the milk of the ass.

The clot is not tough, but semifluid, - like thick cream, - and often offers no resistance to the pressure of the finger. It is necessary to give only small amounts of undiluted milk; and, in strict attention to this rule lies the while success of this method of infant feeding. For infants who have been breast-fed, the amount of undiluted milk should be half the quantity obtained from the mammary gland, ascertained by weighing the infant immediately before and after suckling. At first dilution may be necessary, but it can soon be rapidly diminished, and then discontinued altogether. If the infant is fed solely on undiluted milk, only a small amount should be given; and this should be increased or decreased only when the curve of the weight indicates the need for some alteration of the diet.

As a rule, Professor Budin does not allow broth, gravies, or any other food, but prescribes only milk, or pap made with milk, during the first two years. He rarely orders more than 1000 to 1200 grammes of milk, even for infants in their second year. Amongst his nurslings the tumid abdomen is almost unknown: he has only seen one case at the "Consultation", which was cured when a reduction was made in the child's allowance of milk. The so-called "undiluted milk dyspepsia" he is unacquainted with. The stools of the infant fed on undiluted milk should be yellow: white stools of consistency of putty indicate that the infant is overfed. This treatment should be of service in the management of rachitic infants: for Professor Budin declares that, since he began in 1892, there has not been at the hospital a single case of rickets. In "The Nursling" he publishes an account and chart of a rachitic infant brought to the consultation. The child was taking 2,500 grms. of fluid daily, which Professor Budin at first reduced to 1125 grms. of undiluted milk; and, after initial failure, he was able to reduce this to 900 grms. From the thirty-fourth to the fifty-seventh week, the child on this amount gained steadily in weight, and the only addition made was a few teaspoonfuls of flour to some of the feeds (op. cit., p. 144).

Comby also uses pure sterilised milk, and finds that dilution is rarely required; it is also used by



Variot, but he prefers to dilute the milk with one-third of water during the first six weeks of life.

Fitschen (Arch.f.Kinderh., Vol. xxxviii) has used undiluted milk as early as the tenth day of life, and states that it is most suitable for infants over the age of four weeks.

Professor Budin has never seen a case of scurvy due to feeding with sterilised undiluted milk. He asks what constitutes the "antiscorbutic" properties of fresh milk, and does not understand how sterilisation should cause them to disappear.

Henry Ashby has reported a case due to prolonged use of sterilised milk supplied by municipal authorities, but the mixture was so-called "humanised", and not undiluted milk.

W. Cheadle (Lectures on the Practice of Medicine, p. 197 et seq.) also reports a case of scurvy from sterilised milk, but in some cases the milk was also humanised, or patent foods used in addition.

S. Still considers that the sterilisation of milk is bad, because it interferes with its nutritive properties.

Many authorities maintain that sterilised milk interferes with development, produces soft muscles, and a weakened resistance to infectious diseases. This, however, is not Budin's experience: for he finds that children, brought up on sterilised milk, compare very favourably with those who have been fed by other methods.

Professor Ausset uses pasteurised milk at his "Goutte de Lait", and finds that he can feed infants from the first on pure milk; but, if the milk has been sterilised, it is necessary to dilute it until the infant is four months of age.

The feeding of infants with cow's milk diluted to various degrees is often very unsatisfactory; and the brilliant results of Professor Budin, and other French pediatricists, suggest that the solution of the difficult problem of infant feeding is not to be found by diluting cow's milk until it approximates to mother's milk, but by boldly giving small amounts of undiluted sterilised milk.

This method certainly merits a wider trial in England; but all children thus treated should be under the careful and constant supervision of a medical man, who could watch their growth, weight, and nutrition week by week: for the great danger to be anticipated is an unauthorised increase in the quantity of the milk by the anxious parents, who cannot estimate the value of the quality of a food, but judge only by the amount seen in the feeding bottle. Many of the diarrhoeas of infancy are due to infection from impure milk, and not from indigestion; and, as these attacks often lead on to malnutrition or rickets, strict sterilisation of all milk may help to prevent or cure these diseases. Amongst the poor, therefore, the sterilisation of milk may assist in preventing the spread of rickets, and should be insisted upon, if the mother is incompetent or has a dirty home.

It is important that the feeding of the child takes place at regular intervals. In the early weeks, every three hours; between six weeks and two months, every two

and a half hours; from three to nine months, every three hours; and during the remainder of the first year, every four hours. The feedings should be regulated by the clock. It is advisable to wake a child of asleep at the feeding time, - partly in order to educate it into a regular habit of taking its meals, and to prevent it taking an excess if left without food for too long a time, and also because an infant that sleeps too heavily may really be suffering from starvation. During the early weeks, two nocturnal feedings are necessary; from this up to five months, only one; and thereafter the infant should be accustomed to sleep from 10 p.m. to 6 a.m. the next day. The education of the child in early life into regular habits and times of feeding is most important; it should never be given food in the intervals between meals, but, if thirsty, infants are much benefited by little drinks of good fresh (or boiled) water.

As a rule, children are not given sufficient water in the first year, but are dosed with too many feeds of milk, with consequent indigestion. In the case of certain children, nutrition begins to flag about the seventh month, if kept solely on a milk and water mixture; and the writer has frequently had failures from a too rigid adherence to this diet, and has been mortified to find that, when the mother has added boiled bread to the mixture, there was immediate improvement and gain in weight. Unfortunately, this demonstration of the value of boiled bread, though of advantage to an individual child, is apt to prejudice all the neighbours against plain milk mixtures, and spoils all attempts that have been made to educate the mothers to the danger of adding starchy stuffs to the milk of young infants.

Wm. Hartshorn (Med. Rec., June, 1903) supports this statement: for he finds that, after seven months, babies artificially fed, whose digestion will permit it, increase more rapidly, if bread and milk are added to the diet. The crust should be removed from the loaf, the pulp is scalded, and, after pouring off the water, milk is added, the whole boiled for three or four minutes, and then cooled and sweetened. He advises that never more than half an ounce be given at one time. At this age, the bread-jelly of Cheadle, if properly prepared, is of great service.

#### DIET DURING THE SECOND YEAR.

As the child approaches the end of the first year, the problem of feeding is not so difficult, as it now becomes a mixed feeder. And, as the stomach of the artificially-fed infant has been trained to digest a food never intended by nature for its digestive juices to manipulate, it is able more readily to digest and assimilate the assortment of foods now offered for consumption. During this period, the artificially-fed infant may be able to gain ground on a breast-fed infant, unless, during weaning, the stomach of the latter has been trained to digest and assimilate other food stuffs.

As dilatation of the stomach, and motor insufficiency with chronic gastritis, are of common occurrence in rachitis, great care must be exercised that the stomach is not overloaded with excess, or too great a variety of food. At this period of life, the patent foods are still far too much employed by all classes of mothers, and they

should be largely replaced by fresh food from the kitchen. The usual plea is that patent foods are so convenient, but they are certainly not cheap for prolonged use in the home. With the exception of a few malted foods, they are wholly unnecessary; and it is a very simple matter to dextrinise starch jellies at home by using a reliable malt-extract preparation.

The writer urges that, in the place of patent foods, bread-jelly, barley- and oat-jelly, or rice cream - all freshly prepared - should alone be found in the modern nursery. If this were the rule, the mother would know exactly what food the child is eating, and also that it is freshly prepared, and of good quality. All starchy preparations should be first soaked for some hours, and then cooked very slowly - preferably in a double saucepan. Barley- or oatmeal-jelly can be easily made by soaking the cereal (four ounces) in a quart of cold water for twelve hours. The mixture is then boiled down, so as to make a pint, and is strained through a fine cloth while it is hot. A little salt can now be added. Different proportions of the jelly can be used, but it is usual to begin with equal parts of jelly and milk.

Various authorities differ slightly as to the foods allowed to a child during the second year; and it is always advisable to study the individual, and arrange the diet list for each case. The staple food should still be milk; but it should be remembered that the high percentage of haemoglobin which was present in the blood of the infant decreases towards the end of the first year, and milk does not supply the blood-making organs a sufficient amount to replace it, and other foods therefore become necessary. Consequently, even between twelve and eighteen months, a child still requires careful supervision; and meat broths, milk puddings, lightly cooked eggs, and custards should be slowly added to its dietary. About the middle of the second year, pulped fish or meat may be given in small quantities, with toast or bread and butter. It is sometimes better to give very little starchy food with the mid-day meal; there is a considerable number of puddings containing no starch that can be made use of, and they also give the spice of variety. A selection can be made from baked custard, junket, fruit soufflé, lemon sponge, and chocolate mould. The tendency is to give the child too much starchy food during the second year; and this should be specially avoided in treating a case of rickets.

The use of vegetables, except in broths or purées, requires great caution. Potato soup is valuable, if the child shows signs of rickets; and spinach may be a useful addition, as it is a vegetable rich in iron. Purées of lentils, beans, calves' brains, sweetbreads, and the roe of fish are valuable, as they are all rich in phosphate of lime. Fruit-juice may often be given with advantage, but it should be administered at least one hour after the exhibition of a milk food. Even during the second year, if rickets is present to any great extent, the impairment of the digestive functions will prevent any rapid advance towards solid food. It may be safer to keep the child on top-milk mixtures modified to suit its digestive powers, whey and milk, milk with sodium citrate, with a little rusk, bread-jelly, or oatmeal porridge. Oat flour, being rich in



proteid and fat, is especially useful. Beef-tea, raw meat, juice or pulp, pounded and underdone meat, or part of the yolk of an egg, may help to vary the diet. If there is anaemia, the raw meat-juice should be given daily. The fats must be increased by giving extra cream, bacon fat, and butter.

It may be an advantage to give the child a considerable quantity of its starchy food, as dry rusks or biscuits, in order to make it masticate (unless the rickety child has too few teeth): for this stimulates the salivary glands to perform their functions. Very often the rickety child with a dilated stomach will take food better, if the starchy element is given in this way, and the milk administered slowly as a drink; and sometimes it is an advantage to give the fluid sometime after the food. By this means the tendency to flatulence and fermentation, set up by soaked food, may be lessened, and the comfort of the child increased.

Freeman (Arch. Ped., Vol. xxi, p. 403) is of the opinion that too great a variety of food is given during the second year, and too little milk. This is undoubtedly a frequent danger: for when once the parent is allowed more latitude, she is tempted to give the child too many tastes of various foods, and often increases the amount of starchy elements at the expense of the milk.

It is necessary to insist - especially in treating rickets - that no cakes or sweetstuffs be given during the second year. The less the child knows of such dainties the better: for they will only spoil the appetite, or cause it to refuse plain and wholesome food. The common practice of giving the child "anything that is going" is most reprehensible, and often leads to digestive disorders. The Sunday dinner, when the entire family feed the baby, only too often brings disasters in its train.

Freeman (loc. cit.) gives three indications that a child is being properly fed: (1) a healthy complexion, (2) a clean tongue, and (3) well-digested motions.

Children carefully fed, as evidenced by these important signs, are less liable to broncho-pneumonia and gastro-enteritis. It is therefore important to strive to raise the rickety child as speedily as possible to this standard.

In rickets it may be necessary to supplement the amount of one or other element of the milk by others of a more digestible or assimilable nature. If, owing to the indigestibility of the casein, the child is receiving insufficient proteid, this element can be supplemented by giving albumins, - such as the white of an egg, - with one of the meals, or by adding raw meat-juice to the bottles. The meat-juice should be freshly prepared twice a day, and not obtained from the chemist, as most of the much lauded preparations consist mainly of extractives.

The preparations classified as Peptonoids may be of some service, but some contain as much as 23.03% of alcohol, and should be regarded more as stimulants <sup>than</sup> as foods.

Raw meat-juice consists of 5.1 per cent. of proteid, and is so rich in albumin that it coagulates in a solid mass on boiling. It also possesses antiscorbutic properties. A few drops may be added to the milk and be

sufficient, if it is only desired to increase the proteid; but, if the meat-juice is intended to replace the casein of the milk, two drachms may be given for a child of one month of age, or two ounces can be administered to older children in the twenty-four hours. It is of especial value in the treatment of the anaemia of rachitis.

Plasmon, Somatose, Casumen, or similar preparations, may be added to the food; but it is advisable to use freshly prepared foods as far as possible, and none of the proprietary preparations can compare with the raw meat-juice. Older children, the subjects of rachitis, - especially when it is associated with intestinal disorders, - do well on a diet in which meat predominates.

Jacobi mentions that the so-called *erethic* rachitis of thin nervous children requires less meat, but none of the better class of the farinaceous foods - viz., barley and oatmeal, with boiled milk and salt.

#### THE FATS.

The ideal form of fat is cream, as it is an emulsion; but many children find considerable difficulty in digesting any excess in the food, and suffer from fat dyspepsia. Human milk-fat is more finely emulsified than cow-fat, which also contains volatile fatty acids - mainly butyric, palmitic, and stearic acids. These volatile acids in the fat of the cow may cause considerable disturbance of the digestion, and symptoms of auto-intoxication. At certain seasons of the year, the addition of oil cake to the food of the cow is apt to aggravate the dyspeptic troubles, and bring on troublesome diarrhoea in infants.

When cream is not well borne, a fat that is often of value in the feeding of infants is the yolk of the hen's egg; it may be added raw, in small quantities, to the bottles, or given separately - either raw or slightly cooked. The yolk of egg also contains a considerable quantity of lecithin, and, by adding yolk to the food, the deficiency of that compound in cow's milk may be filled up, and utilised to build up the nerve cells in the body. Yolk of egg contains very little volatile acid, a diastatic ferment, is readily absorbable, and stimulates digestion.

L. Stern (Arch. Ped., Vol. xxii, 1905, p. 441) finds that the best results are obtained from the yolk of egg, if it entirely replaces the milk-fat. He estimates that the yolk of one egg is equivalent to one ounce of cream, and that a teaspoonful of yolk, or 10 c.c. of cream, contain equal quantities of fat. Half a teaspoonful of yolk of egg (two grains) is equivalent to a 1 per cent. fat mixture. The yolk of egg can be given with skimmed milk or whey, preferably free from acid or alcohol.

A patent preparation, known as Virol, is a compound composed of yolk of egg, malt-extract, lemon-juice, and 20 per cent. of bone-marrow. Used with some reservation, it should prove at times a useful addition to the food of rachitic children. The writer has found it useful in the anaemia of early infancy, when the onset of rickets may be apprehended; but it is not always well borne, and older children sometimes object to the taste.

Burnet (Med. Times & Hosp. Gaz., Dec. 10, 1904) finds that Virol is often retained when cod-liver oil is

vomited. He gives notes of six cases of rickets, varying in age from nine to seventeen and a half months, that did well on this preparation, and is of the opinion that it may be given to young infants. He compares Virol with cod-liver oil, to the advantage of the former, and gives five reasons:

- (1) Virol can be given when cod-liver oil is vomited.
- (2) It can be administered during the hot weather.
- (3) It never causes a distaste for food.
- (4) It is palatable.
- (5) It is a reliable preparation.

F. J. Poynton (Brit. Med. J. 1906, October 21, p. 1021) endeavours, as far as possible, to feed infants on two parts of milk and one part of water, and finds that it is better borne if citrate of soda is added to the mixture. For the poor, he often adds, with success, a proprietary preparation of bone-marrow, as cream is frequently unsatisfactory or beyond their means.

Leakey and Ransom (Med. Times & Hosp. Gaz., Aug. 11, 1906) have given Virol in large quantities, two and a half ounces daily for three months, in cases of marasmus, and with no ill effects; but the writer has never been able to push this food to any extent without causing indigestion or gastric disturbance. For infants, it is best administered in gruel, which it partly dextrinises; older children can take it from a spoon on given on bread and butter.

Hutchinson (Patent Foods and Patent Medicines, p. 19) does not regard Virol as a food with any higher value than chocolate or toffee. He estimates that it contains 20 per cent. of fat, and 60 per cent. of carbohydrate.

Nevertheless, the writer considers it a very useful help in certain cases of malnutrition, anaemia, and rickets - in which affections it seems to be a very assimilable food. Extra fat may also be given with the food, or immediately afterwards as an oil; and cod-liver oil is often the best medicament for this purpose. It should be classed as a food, though it has distinct medicinal properties; but at the present it may be considered as an adjunct to the diet of a rachitic child.

Gautier and Morgue (Twentieth Century Prac. of Med., p. 558) explain the action of cod-liver oil by (1) the easy assimilation of its fatty bodies, (2) its richness in phosphates, phosphoglyceric acid, lecithin, and phosphorus in organic combination, and (3) the presence of small quantities of iodine and bromine.

Very often children are given cod-liver oil in too large doses - with the result that a feeble digestion is hopelessly upset, and the appetite impaired. It is not necessary to dose all rachitic children with cod-liver oil: for sufficient may already be supplied to the system, if there is an adequate amount of cream in the diet. If cream and cod-liver oil are both given, the point at which the infant can safely digest the fat and prot-eid may be overstepped, and evil consequences result.

Jacobi (Therapeutics of Infancy and Childhood) does not hold that the value of cod-liver oil in the treatment of rachitis lies only in its fat, and does not





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believe that three teaspoonfuls of cream or other fat can replace an equal amount of cod-liver oil.

Cheadle considers that cream is quite as efficient as cod-liver oil, and warns against drenching the unfortunate rachitic patient with cod-liver oil and chemical food - especially if the fat in the diet has not been properly adjusted.

Hutchinson (op.cit., p.18) does not see any reason for ordering cod-liver oil emulsion, if the only requirement is an easily-digested fat, when there are such substances as ordinary cream and butter procurable. Other substitutes for cream or cod-liver oil are obtainable.

These supply the necessary fat, and are such substances as olive- and salad-oil, and lipanin, - a combination of olive-oil with 5 per cent. of oleic acid, which renders it more digestible. The latter is a useful remedy in hyperchlorhydria, - so that it may also be of service in the acid dyspepsia of rachitis.

Maltolivine (Extra Pharmacopœia), a compound of olive-oil and malt-extract, is recommended as a cheap substitute for cod-liver oil. After the age of eighteen months, the fats may be increased by the cautious use of melted bacon, mutton fat, or suet.

Fucol has been recommended as a substitute for cod-liver oil, because it has a pleasant taste, and does not give rise to digestive disturbances. The dose for children varies from one to three teaspoonfuls a day (Merck's Annual Report, 1905, p.85).

In CONCLUSION, it is advisable to supply the fat as far as possible in calculated doses; and this can best be estimated by giving it in top-milk or cream, when the percentage can easily be calculated. If the fat is given as an oil, - either plain or as a medicinal agent, - the amount of total fat must be watched, and any digestive disorders regarded as a sign for its immediate diminution or discontinuance.

It is seldom necessary or advisable to increase the amount of the sugar. It is better to give a sufficiency of lactose or cane-sugar in the food than to supplement it with malt-extracts, which have not so good a food value, and are very much more expensive. Malt-extract may be useful in the feeding of infants, - on account of its diastatic action upon starch, - and often renders the gruels easier of assimilation. The alcoholic dextrins present in stout may even be of greater value in cases of profound malnutrition. They have been shown by Langford Syme (Brit. Jour. Childn. Dis., Vol. iii, p.290) to be particularly valuable in the treatment of marasmus, though the indiscriminate prescribing of this remedy for the rickety children of the poor is not, for obvious reasons, advisable. Nevertheless, in emergencies, stout might prove a useful remedy to tide the infant over some crisis or difficulty arising from exhaustion or malnutrition.

In the treatment of rickets, the diet should always receive the first consideration. Though it may not be altogether possible to treat a case of rickets without having recourse to drugs, the number used might be

considerably diminished, if the diet is carefully supervised and arranged for every case, and also altered by the physician as the child progresses towards recovery. Attention to the small details, and careful consideration of the necessity for the instruction of the mother in the preparations or cooking of various foods will give quicker and better results than can be obtained from any specific drugs or remedies, when a case of rachitis is under consideration and treatment. The medical man should be able to explain the best foods and mixtures that can be prepared at home, and should seldom or never rely on the unsatisfactory compounds that are made from proprietary patent foods. They should be regarded as emergency foods, and not as regular articles of an infant's dietary.

## THE ENVIRONMENT.

### ----- GENERAL CONSIDERATIONS.

The rickety child should be placed in the best possible environment; it should live and sleep in a well-ventilated apartment, and have an abundance of fresh air and sunlight, - though, at the same time, care must be taken to protect it from cold and damp; its clothing should be warm, but not excessively heavy or impervious to ventilation; and its general health may be still further improved by daily baths, friction, and massage. By attention to all rules of hygiene, the body is made more resistant to chill; and the blood, better oxygenated, can cope more effectually with the toxins of disease.

It is not always possible, however, to treat in this thorough manner cases seen only at a hospital; but, in private practice, if a case of rickets is brought to the consulting room for advice, the physician should, whenever possible, visit his patient, and satisfy himself that it is living under the best hygienic conditions that the circumstances will allow, and, if he detect therein any gross errors, - such as lack of proper ventilation, or want of cleanliness of the home or person, - he can then endeavour to correct them, and thus put his patient in a better position for making a more speedy and satisfactory recovery. At the same time, he can assure himself that the details in connection with the feeding of the child are properly carried out, and that the milk is obtained from a reliable source, and kept in a suitable place carefully guarded from the risk of contamination.

Rickets will never be cured solely by the distribution of a pamphlet on infant feeding to the mother, and a bottle of medicine to the child. If cases are to be efficiently treated, all the small details of the general hygiene must be supervised, and proper attention paid to all the minor matters, which mean so much to the welfare of the delicate infant, - until, by slow degrees, a better standard of living is attained, and made permanent in every home of rich and poor alike.

"To give society its highest taste  
Well ordered home man's best delight to make".



The medical man should lay down strict rules for the child's diet, baths, fresh air, exercise, and clothing, and should insist on their proper observance. If a nurse has the principal charge of an infant, it is seldom wise to rely solely upon her word or her management: for these women are notoriously very careless, often untruthful, and can seldom be trusted to carry out detailed directions in a responsible and honest manner.

#### FRESH AIR.

The public have been educated by slow degrees to recognise the value of fresh air in the treatment of tuberculosis; they must also learn that it is equally effective and salutary when applied as a curative agent to the infant suffering from rachitic disease, marasmus, and many other disorders. If the child is a dweller in the town, it must be taken out constantly into the open air, and, when its home is near a park or open spaces, it must be made to spend the greater part of its daily life in one of these "lungs" of a city, as far removed from the slums as possible.

In cases where the parents are able to send the child away, a prolonged stay on the seacoast should always be recommended: for the tonic and bracing action of the sea air, charged with ozone and salt, promptly benefits most cases of rickets, and hastens their cure. It may, however, be necessary to keep the patient at the seaside for months, and it is well to forbid any return to town until convalescence is fully established. The advantages of sea air were first pointed out by R. Russell in 1750, and the pioneer watering place established in England for delicate children was Margate. Cases suffering from chronic diarrhoea recover more rapidly when brought to the seaside; and, as a rule, in rickets sea air is found to have an advantage over that of inland country, but, if chronic bronchitis is present, the humid atmosphere of the coast does not benefit a patient so much as mountain air. A child can be safely taken out during the winter months, if it is well covered and protected from draughts; often it is advisable to give a little warm food, before leaving the house, to help in keeping up the body heat during the time it remains out of doors.

It may not be within a medical man's power to effect much change in the home or in the manner of the living of its inmates: for the force of circumstances, or the pinch of poverty, may be the masters of the situation. Nevertheless, he must preach the gospel of perfection and endeavour to obtain any improvements or alterations he can, if the home life is manifestly unhygienic and unsatisfactory. He can insist on all the living rooms being well ventilated, though the poor seem to prefer to live in rooms, the windows of which are hermetically sealed; and, as they herd together, the atmosphere becomes full of toxic products, and the child is kept always living in a stuffy and impure atmosphere. Many nurseries are kept at too high a temperature, - so that, when the child is taken from the overheated room into the open air, it is constantly catching cold, and is then shut up in a vapour-bath atmosphere until it shows signs of

recovery, with the result that the powers of resistance to disease are continually lowered and its vitality depressed. The writer has seen an unfortunate infant kept indoors for the first seven months of its life, through an entire, but by no means inclement, winter - the natural result being the development of rickets, anaemia, and a liability to frequent attacks of bronchopneumonia.

Whenever circumstances will permit, separate rooms should be used for the day and night nursery. A rickety child should live in a sunny well-ventilated apartment, well lighted, and kept free from dust by making its scheme of decoration as simple as possible. The walls of the room can be coated with a washable distemper; thick carpets should be replaced by cork linoleum, or even with well-washed and polished floors; heavy curtains must not be allowed to screen the windows and prevent the free access of sunlight, or catch the dust and hold it: so preference should be given to light and washable hangings. The floor-space should not be overcrowded with an excess of useless furniture and ornaments. In the nursery everything should be plain, and the room should never be allowed to become stuffy. Even in the houses of the poor, spotless cleanliness ought to be found; but this can never be expected while the woman works all day at the factory, or endeavours to support the home by adding her pittance to the other weakly earnings.

A child will never suffer harm from fresh air, however cold; but its skin and mucous membranes are very susceptible to sudden draughts, - so that, if it is allowed to crawl about the floors, great care must be taken that it is protected from this danger. Windows ought to be kept open day and night. There is no real danger in night air, except under exceptional conditions, as when the atmosphere is heavily charged with moisture; and, even at these times, it is healthier than an atmosphere overcharged with carbonic acid and the foetid exhalations of many sleepers. Fresh air is a stimulant and a tonic; it braces up the constitution; promotes appetite; improves the ~~gastro~~ functions; and calms nervous irritability, - and thus, in an ideal manner, fulfils all the indications required in the selection of a perfect remedy for the cure of rickets.

The value of attention to the rules of hygiene, combined with proper feeding, is well illustrated by a comparison of the Jewish and Italian slum children. Amongst the Jewish poor, the children are strong and healthy; they are well cared for, their homes and persons are clean, and their food well regulated, - so that, in this community, only a small percentage suffer from rickets. On the other hand, the Italian children, so long as they are living under the bright blue sky and in the warm sunny atmosphere of their native land, are reasonably healthy and hardy, but, when transplanted to America, - where they dwell in crowded tenements, and breathe daily an impure atmosphere, - rickets spreads amongst them like an infectious disease.

Mr. H. S. Wells, - that keen observer of human life and of the workings of the manifold social elements, -

takes notice of this in his latest work "The Future in America". He examines the homes of the Italian immigrants, and it seems to him worse than the one he left behind him in Italy: "It is just as dirty, it is no more wholesome, the moral atmosphere far less wholesome as a consequence, the child of the immigrant is a worse man than his father". Small wonder, then, that rickets springs up amongst them, and attacks even the infant at the breast!

It is a delight amongst the poor to crowd together into a single living room, probably the kitchen, and, if there is a sick and ailing child, the poor thing is so surrounded by women and visitors that it can seldom or never breathe air that is pure and freely charged with oxygen. If we accept Kassowitz's statement, that crowd poisons and the products of organic decomposition are the chief causative factors in the development of rickets, we must keep all our cases freely in the open air or in well-ventilated apartments, strive to place all invalid children under better hygienic conditions, and prevent unnecessary pollution of the sick-room by crowds of well-meaning, but undesirable and unhealthy, friends and visitors.

#### SUNLIGHT.

Sunlight is an important factor in promoting the cure of rickets; for in bright sunny countries - such as India - the disease is almost unknown, but, in the temperature climates, - especially in those parts of the world where the winters are long, dark, and sunless, - the disease is particularly prevalent. Sunlight is also nature's greatest tonic; it promotes growth, life, and energy, and also inhibits the growth of inimical micro-organisms.

The convalescence of a rickety child is greatly hastened if it can be kept constantly exposed to the influence of bright sunlight, which seems to influence cell growth and nutrition. Sunlight is of especial service in cases recovering from diarrhoea or pulmonary disorders. It is not always possible to remove the patient to a country with a sunnier climate, but every opportunity must be taken to keep the patient out of doors at the open window, and exposed as much as possible to the action of the solar rays.

Cases of rickets seldom do well in ordinary hospitals, but, if these children could be sent to convalescent homes in the country or by the seaside, or to hospitals specially designed for their chronic diseases, - which have ample facilities for keeping them out of doors, and are able to place them in "sun rooms" during inclement weather, - good results could certainly be obtained; and for the town dwellers in the slums these institutions should prove priceless boons.

In many large and crowded cities, the introduction of "roof gardens" might be made very useful in the treatment of the children of the poor; and, in America, cases of pneumonia have done exceedingly well when placed under these conditions. Roof gardens possess distinct advantages; the air is purer and freer of dust, sunlight is more readily obtained, and the noise from the streets



and traffic is lessened, and made less objectionable. Cases of rickets should do very well if kept out all the day, and sunned upon the housetops.

### WARMTH.

Warmth is only second in importance to food, alike in the treatment of rickets, and in promoting the health and welfare of all growing infants. Children are more sensitive to sudden changes from heat to cold than adults, and the rickety individual, - usually with a subnormal temperature, and with mucous membranes hypersensitive to changes of temperature, or external irritations, - demands that special precautions should be taken against the evil effects of a chill.

An invalid child should always be protected against the depressing effect which cold may have on the respiratory tract; and it is also equally important to keep the abdomen and feet thoroughly dry and warm, in order to ward off catarrhs of the bowels, bladder, or kidneys. The body heat must be kept up and regulated by warm clothing, foods containing fats and sugars, and by careful protection from cold winds and sudden draughts.

A rickety child should never be taken suddenly from a warm room into the cold air outside; but, if its apartments are well ventilated and the windows are kept freely open, the risk of chills is considerably minimized: for the body becomes more resistant to varying degrees of temperature.

Children who are always catching cold have a depressed vitality, as well as a low resisting-power to microbic infection; this is particularly well illustrated by the ease with which children, suffering from adenoid growths or rickets, develop pharyngeal or bronchial catarrhs under the slightest provocation. They also throw off these complaints with difficulty, taking three or four weeks to recover thoroughly, instead of getting well in a few days. The initial cause of the cold is a sudden chilling of the surface of the skin, but in most cases it will also be found that the digestion is at fault, and that the system is overcharged and hampered by waste products which throw an extra strain on the excretory organs. In some cases, however, sudden abstraction of heat may alone be sufficient to cause a cold by lowering the vitality.

Children with digestive and excretory organs acting in a normal manner resist chills, because they are better able to withstand its depressing influences; but, in rickets, nutrition is low, and vitality feeble. Furthermore, digestion is bad and working at a disadvantage, - so that the child has no powers of resistance, and readily falls a victim to any sudden chill, which may attack its system. Children lose heat more rapidly than adults, on account of their smaller size: for small bodies cool at a quicker rate than those that are larger: this should be remembered, and due allowance made, so as to guard against exposing those of tender years too unduly to adverse conditions. Unfortunately, the children of the poor are only too frequently called upon to withstand sudden changes of temperature, by being taken in and out of places in which the atmosphere is foul, vitiated, and overheated, and their vitality further depressed by

contact with the cold night air. It is only too common a sight to see these poor little morsels of humanity out of doors, late at night, in bitter inclement weather, and, while their bodies are chilled by cutting winds, they are deprived of food, rest, warmth, and sleep, by being carried or dragged about by their mothers, who prefer to gape and stare into the shop windows rather than pay attention to their houses. Infants and children are even taken into noisy shops and bazaars, where the light is glaring, the atmosphere impure, and noisy hurrying people jostle one another in excited masses - a condition of affairs bad for infantile bodies and nerves, and made worse by their being taken suddenly from the warm atmosphere out again into the cold bleak streets.

Many babies are carried out and spend the evening at a theatre or other place of amusement, when they should be sleeping quietly in a cot; but the mother, tired of the monotony of the home and unable to leave the house without her infant, drags it with her into places crowded with people, and risks its life or well-being in attempts to satisfy her craving for excitement, pleasure, or amusement.

In summer, similar bad practices can be observed daily: for every excursion train or boat pours out a seething mass of pleasure-seekers, returning at a late hour to their homes - amongst the crowd being many children, and even women with infants suckling at the breast. All are tired; old and young are often jaded and irritable; and this overfatigue, and deprivation of natural rest cannot fail but react badly on a nursing mother, her infant, or young children. The continual craving for excitement or pleasure is strong amongst the masses - especially those who work in factories; and no one denies the necessity for change to help towards brightening their weary existence, and to lighten their lives of toil; but pleasure-seeking unfortunately leads to unrest, excitement, irregular meals, and late hours, which must tell back in an injurious fashion upon the health of the infants and young children, interfering with steady growth and development, and injuring especially the immature and unstable nervous system. The mother during part of her life must learn to sacrifice enjoyment for the good of her child.

Still more terrible is the evil practice - only too common amongst women of the poor - of taking infants and young children into the hot unhealthy atmosphere of public houses, where the depressing effect upon the vitality of the child is made still worse by the habit of giving it sups of gin or other spirits, and even of thrusting a foul and dirty pipe into its mouth in order to keep it quiet. Gin and nicotine to an unweaned infant!!!

George R. Sims has drawn public attention to this horrible condition of affairs in a series of powerful, but unpleasant, articles, entitled "The Cry of the Children", which appear in the pages of "The Tribune"; and he makes it only too evident that mothers, by seeking at

the bars of public houses solace from the gloom and discomfort of their homes, nightly waste money in alcohol, which is badly needed to pay for better food for themselves and their suckling infants. Still further, he shows how the unweaned infant and the toddling child are kept in the foul atmosphere of the tavern until past midnight, and then taken out into the cold streets; and thus the lives of innocent children are sacrificed to satisfy the cravings of the mothers for the pleasures and enjoyments of life.

These are social evils, but, so long as they exist, how can we hope to treat rickets with any success amongst the children of the poor? Even if care is taken to improve the food-supply, - and many of these mothers have deep affection for their infants, and would stint themselves to provide for their wants, - yet, the depressing influences of bad hygiene, impure atmosphere, want of rest, cold, and unnatural excitement still remain to be combated; and, until the mother can be educated up to a higher and more moral plane and will be content to sacrifice herself for the good of her offspring, this disease cannot be eradicated from the slums and crowded courts, or from the tenement houses of our great cities.

### REST AND EXERCISE.

#### REST.

In the preceding pages the inadequate rest given to the children of the poor, and its injurious effect upon their vitality, has been commented upon as a modern social evil.

The writer would insist upon the need for keeping infants - and especially rachitic children - extremely quiet, though this, in crowded noisy towns and modern houses, may be a counsel of perfection. Still, much may be done by early and systematic training of the infant, who should be accustomed to go to sleep at regular intervals. After some warm food, it should be put to sleep in a well-ventilated and darkened room, or if in the perambulator, it should be laid flat, and when out of doors it must not be exposed to bright sunlight. This may seem an unnecessary caution, but rickety children, when asleep, are often kept out and exposed to sunlight, on account of the idea that it is part of the treatment of the disease.

All children should be trained to go to sleep without the aid of a comforter or dummy teat, and vigorous rocking is quite unnecessary, and often harmful. The cot should not be thickly padded, and only light hangings, sufficient to keep off the draught, should be permitted; the sides should be open to allow free access of air all about the sleeper. The rickety infant, with its tendency to profuse sweating, requires to be kept cool, and the free circulation of air around it can only prove of benefit.

Extra rest is very essential in rickets; for the hypersensitive brain and muscles of the child easily tire, and can only recuperate and gain strength by allowing long periods of repose to mind and body. At night, the practice of putting the child to sleep in



the mother's bed should be sternly discountenanced; there is always the risk of overlaying, and the practice has nothing to recommend it, and is far from healthy.

An efficient cot can be ~~made~~ from a box or a light Japanese basket. The bedclothes should be warm and light; and, if the child suffers from cold feet or poor circulation, it may be advisable for a time to supply extra heat with a hot-water bottle. Only a firm hard pillow should be provided: for, if a soft one is used, the child's head sinks into it, and soon becomes overheated; and thus the habit of profuse sweating - so invariable a sign of rickets - is still further fostered, and indefinitely kept from being cured.

In a great measure, the restlessness of the rachitic child can be controlled by having it comfortably warm, but not overheated, at the same time keeping its room cool and well-ventilated, and, further, by the careful correction of all digestive disorders - taking particular care not to overload the stomach with indigestible food at bedtime. Nor should the child be fed whenever it wakes or cries: the less it has to eat during the night, the better.

Sleep is an important factor in the promotion of growth and nutrition; but the value of rest and quiet to an undeveloped brain and nervous system is far too frequently overlooked in the treatment of infantile ailments. In the case of the adult, the need of the "rest cure", - for jaded and tired nerves, neurasthenia, or hysteria, - is fully recognised; and equally good results can be obtained when it is applied, with proper judgment, in simpler form to the nervous disorders of infants and young children. The infant or growing child, suffering from rickets, has a hypersensitive brain and an unstable nervous system; there is very imperfect nerve-control, and it needs but little excitement to bring on an attack of night-terrors, laryngismus, or convulsions. The rachitic child sleeps badly, and the most frequent causes of its restlessness are adenoids, disordered digestion, or actual neurasthenia. The disease neurasthenia has been observed in young infants, though the most marked cases have been reported from America - a land of hurry and bustle, the home of nerve wear and tear, over-excitability, and neurotic affections. Infants that are dragged about from place to place by fond parents, or taken into crowded, noisy, or brilliantly-lighted rooms, may in time develop nerve-exhaustion; they usually sleep badly, and either refuse food entirely, or suffer from persistent vomiting. Cases that are suffering from vomiting or inability to retain food in the stomach, if the cause is obscure, should be treated for neurasthenia, and kept particularly quiet: for often, behind a disordered digestion, some hyper-excited condition of the nervous system may be detected, which has been brought on by injudicious management of the child. Neurasthenia is very liable to occur in a rickety child, and may greatly retard its recovery.

An infant requires to be kept quiet some little time, both before and after its food; and small children should never be hurried home, and brought in over-walked and over-tired just at ~~med~~ times. They should

always rest for a short time before eating. As the hour for bedtime approaches, children of all ages must be kept quiet, and the nervous system allowed to settle into a tranquil state before they finally retire to rest. Just before being put to bed, the infant must not be taken into a brightly-lighted room, and danced up and down and handled by by fond parents and many admiring friends, nor should small children be permitted to play and romp or get overheated and excited as the hour for rest approaches.

Such procedures can only lead to nervous irritability and undue excitement, followed by disturbed sleep or even worse disasters. In the case of the normal child, restful habits must be cultivated; but the need of a quiet and tranquil life for the sufferer from rickets must be strongly insisted upon, until the nervous system has been restored to a more stable condition. Rickets is a neurosis-maker, and, if to an already unstable nervous system is added also a condition of neurasthenia, any hope of permanent cure of the nerve disorder will be small, and the child left liable to grow up with a neurotic disposition, - possibly prone to epilepsy, hysteria, or minor ailments, - and the prospect for future generations would not be reassuring.

It may seem straining a point to include these measures under the treatment of rachitic disease; but it is only by attention to all these minor details that a rickety child can be put into the best possible hygienic conditions; and the writer is fully convinced of the great value of rest as a curative agent for these long and troublesome cases. Sleeplessness requires to be treated principally by attention to the general condition of the child and its surroundings, aided, in some instances, by warm baths or wet packs, avoiding, as far as possible, any recourse to hypnotic drugs.

#### EXERCISE.

The healthy infant delights in kicking; it crows with delight when, freed from the trammels of its napkins, it lies on the bed and has the full and unrestricted movement of its limbs. Rachitic infants should be encouraged to make free use of their limbs, when resting on their backs: for all active movements promote the nutrition of the muscles, and quicken the circulation of the blood through the tissues, while at the same time, the weight of the body being taken off the extremities, there is no risk of the development of deformities. The prone position encourages expansion of the chest, and allows the spine to assume its natural shape; and it should be preferred to the sitting posture, in which there is some risk of the formation of curvatures. Crawling or sitting positions can never be permitted for any length of time, if the muscles are flabby and soft, or when there is any indication towards curvatures of the bones.

If the child is old enough to go out for walks, it should not be taken any great distance or at too great a pace; and in these small matters nursemaids are only too often great offenders, as they drag their little charges about at far too great a rate for their capabilities or strength. Unless the muscles of the spine are strong and vigorous, the infant should be kept lying

down in its perambulator when taking its airing out of doors. The modern mailcart, in which the child sits bolt upright on a low seat only removed a few inches from the ground, is not a good vehicle, and cannot be recommended for rachitic children. The nose and mouth, being at a low level close to the ground, are ready to inhale a plentiful supply of dust and debris, and the cold air of a swirling wind strikes upwards from the road on to the face and lower extremities, - so that the child is particularly exposed to the risk of poisoning from refuse, or the germs of poisoning of many diseases, and the danger of sudden chills.

If at any time the weather is severe, and the child cannot be taken out of doors, it should be dressed in its ~~outdoor~~ clothes, out in a cot or perambulator, and allowed to spend some hours in a room in which the windows are kept widely open. This method is also particularly applicable when the child is convalescing from catarrhal disease. The rickety child must never be coddled, and its muscles must be stimulated freely by exercise or movement, so as to encourage their growth, nutrition, and activity.

#### CLOTHING.

After food and warmth an infant requires rest for its proper welfare. Clothing, if too tight or heavy, produces constriction of the body or irritation of the skin, restlessness, overheating, exhaustion, and fatigue, - in short, discomfort, as clothes will not allow an infant to obtain any natural rest.

Badly-fitting clothes may interfere with the various functions of the body; if too tight about the neck or thorax, they impede circulation and respiration; about the abdomen, by interfering with peristalsis, they set up indigestion and constipation; from deficient ventilation, cutaneous disorders may ensue; and any cramping of the limbs prevents the free and uncontrolled action of the various muscles, and hinders their growth and development. In infants and rapidly-growing children, it is therefore very important that all clothes should be well made and of suitable material. In rachitis, when the bones are soft and the muscles flabby, the evil effects of constriction or compression become more pronounced, and must be guarded against: for ill-fitting clothes may produce deformities, or hinder proper recovery by causing pressure on the limbs.

The pernicious effect of tight diapers has already been referred to in the course of this dissertation; and care must be taken that they are only loosely applied, and never fixed tightly around the iliac crests, or wedged between the thighs, lest they should lead to a retardation of pelvic development, inhibition of growth, or actual deformity of bone.

A. C. Cotton is of the opinion that the practice of keeping waddis trussed between the thighs is often the original cause of genu valgum in children.

In a case of rickets the mother must be warned of the danger of tight diapers; and, if there is already a tendency to deformity, she may be advised to sew or fasten the napkins loosely to the edge of the child's undervest, instead of round the waist. The <sup>na</sup>napkins are



usually made of Turkey towelling, but in rickets, when they are frequently soiled with the foul and slimy motions, it is far better to use pads of cotton wool, Gamgee tissue, or some sanitary material which can be burny immediately, and thus obviate to some extent any danger of reinfection. The three great essentials for infant's clothing should be:

- (1) Looseness.
- (2) Warmth.
- (3) Readiness of application.

All garments should be simple in shape, so as to take easily on and off; and, in order to avoid unnecessary handling of the baby (often hypersensitive to touch in the case of rickets), they should be made to fasten either all at the back or all at the front. As warmth is an important condition, children should be dressed principally in flannel, or loosely-knitted woollen garments, which should be loose and light in order to permit free movement of the limbs. The neck, arms, and legs should be kept properly covered, and day garments should never be worn at night.

The abdomen requires protection from sudden chills. For this purpose the usual binder, when carelessly applied, is quite ineffective, as it rucks up on the thorax leaving all the parts below unprotected; or it is sewn so tightly round the child's body that it impedes both its respiration and the proper movement of the abdominal organs. Attacks of diarrhoea are often set up by the exposure and sudden chilling of the surface of the abdomen. The binder is best made of soft flannel, or home-made rib-knitted Shetland wool; and, in order to keep it in position, it should be fixed to an under-vest that reaches down to the hips.

For the treatment of the abdominal atony of rickets, Wm. Ewart (Brit. Med. Jour., Oct. 13, 1906, p. 932) recommends the application of a specially-made elastic belt, in which pressure can be adjusted by means of straps and buckles. The belt consists of a broad band, furnished with buckles at one end, and slit into tails at the other extremity, which, when in use, are pulled through the buckles. The belt may be further steadied by understraps passing outside the diaper. The lowermost buckle, usually the fifth, is always fastened first, and is made the tightest of the series; the top strap, which crosses at the level of the epigastrium, should remain fairly loose. The elastic portion of the belt passes over the front of the abdomen, and consists of indiarubber cord ( $\frac{1}{8}$  inch in diameter), laced loosely down the entire front, through two vertical rows of holes, furnished with metallic eyes punched in leather. The lowermost loops are kept shorter than the upper ones, in order to allow the latter easier play. The loops of the cord must all be made to cross in front of the band, by passing the cord, in and out of the two adjoining holes, before crossing it to the other side. The elastic cord remains loose, until it is tightened by the buckling of the belt. Ewart claims the following advantages for the belt:

- (1) An automatic action.
- (2) Lateral support to weak abdominal parietes, and, through them, to every vessel in the splanchnic area.
- (3) Improved distribution of the blood, correcting the apparent oligæmia.
- (4) More effective respiration, which corrects pallor.

The belt also stimulates muscular growth, as it acts the part of a perpetual massage.

Endeavours should be made to obtain an equal distribution of heat over the external surface of the body, and this can only be effected by arranging for an equal weight and distribution of clothing to all parts. Only too commonly, because a child suffers from colds or recurring bronchial catarrh, it has its chest overburdened with clothes, extra wraps, or chest-protectors, while the abdomen, arms, and legs remain bare, or are insufficiently covered and protected from cold and damp. This excessive padding of the chest leads to respiration being hampered, and checks the free expansion of the lungs; moreover, it keeps the child in a constant bath of perspiration, ~~so~~ that the vitality of the heat-regulating apparatus of the skin is lowered, and the moist skin, by allowing sudden abstraction of heat, produces a chill with all its disastrous consequences.

The disorders arising from the sudden chilling of the abdomen are also produced by the action of sudden cold upon the ~~extremities~~ - more particularly when it affects the sensitive soles of the feet. Rickety children should never be allowed to go about in short-sleeved frocks and socks; they ought always to wear a knitted vest with long sleeves, and the outer garment should reach to the wrists. The undervest and combinations are in many cases made too tight, and accordingly constrict the chest and prevent free expansion thereof. It is advisable in older children to examine the fit of these garments. The front of the vest should be unbuttoned, and the shoulders drawn well back; if this causes the fastenings to separate widely, a V-shaped piece must be inserted to allow for freer expansion of the chest. The chest should be allowed free play in the case of children with rickets, and the garments should be made to hang from the shoulders, rather than fasten tightly round the chest.

In rickets, a child frequently suffers from coldness of the extremities, and in extreme cases cyanosis of the hands and feet; it is easily affected by any chill to these parts, and at the same time the evaporation of perspiration further cools the body, and causes congestion of the internal organs. Bare legs become a real source of danger to a child with rickets; socks may occasionally be permitted in the house, but out of doors, except in the mildest of weather, long stockings or woollen gaiters must always be worn. It is often difficult to make mothers adopt this addition to the clothing, but, if the child suffers frequently from bronchitis or diarrhoea, the necessity for warmth to the lower extremities is of vital importance.

Bare arms and legs are a frequent cause of bronchitis, catarrhs, or chronic congestions of the liver and digestive organs; and these parts of the body must always be kept warm and well covered, of the child

suffers from rickets. The growth of bone is also unfavourably influenced by coldness of the limbs, and this is an additional reason for careful attention to this small detail in the clothing of the child.

The absurd custom of dressing children in flimsy frocks with low-cut necks and short sleeves, or in cotton undergarments and socks barely reaching above the ankles, is merely pandering to the vanity or aesthetic tastes of the parents, or it is done under the delusion that in this way the children's bodies can be hardened and made more vigorous. There is no necessity to harden a child: for, as vitality improves, its resisting power grows stronger without artificial aid, and much harm may be done by wilfully exposing a delicate child to the risks of sudden chill. Nor should children with rickets be allowed to go about barefooted; they should always wear suitable shoes: for, in addition to the risks from chill, if the feet are left uncovered, there is the danger of septic inoculation into a cut or abrasion from the refuse of the streets.

As the rachitic child perspires freely about the head and neck, it should never wear a close-fitting bonnet or hood - especially that variety which fits tightly round the skull, enveloping closely the ears and occiput. Its headgear should permit of free ventilation, and for winter wear is best made of wool, but in the summer of some lighter material.

The nightdress must be made of warm flannel, and it is advisable to fashion this garment like a sack, and to keep it fastened below the feet. The rickety child is a restless sleeper; it is perpetually kicking off its bed-clothes, and thus runs a great risk of chills at night; but, if the nightdress does not open below, it will not slip up and leave the abdomen and lower extremities uncovered, and thus the dangers from exposure and cold are considerably diminished.

It is perhaps needless to add that both the outer garments and the underclothing ought to be made of washable material. In rickets, when there is the liability to frequent micturition, and the passage of offensive motions, this precaution is specially necessary.

As the action of the heart is feeble, arterial tone poor, circulation sluggish, the temperature subnormal, and the skin readily cooled by excessive perspirations, it is usually necessary to clothe rachitic children in warmer garments than is usual for those in normal health. The medical man should satisfy himself that his patient has clothes suitable for its delicate and sensitive condition, and be certain that no part of the body is left bare and exposed to the risks of cold or sudden chill. Attention to the details of clothing are very necessary in the thorough treatment of rachitic disease.

#### BATHS.

Baths are useful as tonics, as they improve the circulation, stimulate growth and nutrition, and, if used with proper caution, strengthen and steady the nervous system.

Baths or douches are often valuable therapeutic agents in the treatment of rickets, but they require to



be used with care, if the child is delicate or weakly, or suffering from any intercurrent disease. In the case of weaklings, it may be better for a time to dispense with the bath, and only sponge the patient limb by limb, while it lies on the mother's lap, or even in the cot. If an infant turns blue about the mouth, it is wiser to wait for the complete tubbing until it is older and more resistant; and delicate children at first may be given a tepid bath at night, rather than in the morning.

The usual method employed in the treatment of a case of rickets (after infancy) is to stand or sit the child in a bath at a temperature of 90 - 100° F., and then rapidly douche it with tepid water, beginning at 70° F. and rapidly reducing the temperature as the child becomes more resistant and accustomed to sudden changes.

Douching with salt water has a specially invigorating action upon cases of rickets, and, if sea water is unobtainable, rock-salt or Tidman's sea-salt can be added with advantage to the daily bath. Curvatures of the bone yield to a prolonged course of sea baths, and spinal curvatures rapidly disappear under treatment with douches and massage.

It is very necessary to dry carefully the child's skin: for in rickets there is great liability to eczema, intertrigo, and sweat eruptions. It should be rapidly dried, with vigorous friction, in front of a fire - special attention being paid to all the flexures of the limbs, the folds of the buttocks, and the nape of the neck.

#### MASSAGE.

Massage is a valuable remedy in the treatment of rickets, as it promotes vascular activity, and stimulates the respiration and circulation, which are feeble in this disease, and rendered worse by the flabby and toneless condition of the muscular system. The waste products in the tissues, which act as toxins, are also removed more rapidly and carried into the circulation - to be finally dealt with by the excretory organs.

Massage, when combined with baths and douches, accustoms the skin to changes of temperature, and prevents the frequent tendency to catching chills and the subsequent catarrhs. Massage is of the greatest service in helping to tone up the debilitated muscular system, and it should be applied daily to the muscles of the extremities, the spine and the abdomen, in order to increase their activity, to strengthen the back, and to assist in the correction of constipation. At the same time the activity of the skin may also be stimulated by free friction of its surface.

The effect of the massage may be increased by the employment of stimulating liniments or alcoholic lotions, which, by producing slight counter-irritation of the skin, increase the peripheral circulation; or, if the digestion is weak, fat may be introduced into the system by inunction with cod-liver oil, goose-grease, or bacon-fat. The writer prefers to massage the entire body with plain olive-oil, which answers most requirements and has not the objectionable characteristics of some of the other remedies. When it is necessary to affect the deeper seated muscles, kneading (*pétrissage*) and percussion (*tapotment*) of the tissues should be practised, as well as the gentler methods of friction and massage.

ELECTRICITY.

A mild current of electricity - by reason of its stimulating properties - promotes muscular and nervous activity and is helpful in the treatment of certain cases of rickets, though its use is limited to a certain degree, as many children are greatly terrified when it is applied to the skin.

Electricity in the treatment of rickets is highly praised by Dr. Tedeschi of Padua, who first employed it for these cases in 1882. He makes use of the continuous current, and also the electric bath, and finds that their application influences the sweating, insomnia, pains in the limbs, and laryngismus.

Wm. Ewart, observing that good results were obtained from the use of the sinusoidal current in the cardio-abdominal atony of broken compensation, was induced to give it a trial in the treatment of rachitis: its application seldom causes either discomfort or alarm. His usual method is to give it in a bath, or through a double hand- or foot-bath, each separate trough containing an electrode; and, by using this apparatus, the entire current is made to pass through both limbs and also the trunk.

Though the writer has had no opportunity of trying it, the high-frequency current ought to give good results in certain cases of rickets.

The X-rays - by reason of their powerful penetrating action - are capable of producing profound disturbances of the cellular equilibrium of the blood and tissues. The full extent of their value for medical purposes is not clearly understood; but the rays have been employed to assist in the cure of leukaemia and splenic anaemia (Banti's disease) with good results (Bryon Bramwell, - Clinical Studies, Vol. iv, p. 34). It is probable, moreover, that, if used with discrimination, they might also prove a valuable therapeutic addition to the various means at our disposal for the treatment of rickets, and be particularly useful during the period of the year when sunlight is not available for any length of time.

The writer is not aware if this method of treatment has been tried in England; but, in America, the case of a boy, - aged one year and suffering from rickets and hydrocephalus, - is reported by Margaret Cleaves, in which treatment with the X-rays produced immediate and lasting benefit and improvement: whereas, under ordinary treatment, the child had steadily lost ground and drifted into an apparently hopeless condition. At first the X-rays were applied to the head only, and, after four days under its influence, the child became brighter, and sat up from the prone position unassisted for the first time. The anaemia improved, and the exaggerated pulsation at the anterior fontanelle diminished considerably. At the end of the first week, the child was placed naked in an arc-light cabinet, and the whole body exposed to the energy of 10 ampere arc lamps. While under the influence of the arc-light, the child always became much livelier, and used his legs with great freedom, kicking them up in the air in playful fashion, and with evident enjoyment. Under the light-treatment, in seven weeks the child gained 3.3 pounds; there was

also marked increase in length and circumference of the head and chest. The colour was good, lips and cheeks were rosy, and teeth began to show through the gums. The general muscularity improved so greatly that the child was able to stand alone for a few moments, and almost managed to crawl in an ungainly fashion. From being lethargic and apparently moribund, the boy grew bright and took an interest in everything about him, and his intelligence was up to the normal standard for his age. The arc-light had a powerful excito-motor influence upon the child: for it always stimulated him to freely move his limbs, and cry with enjoyment, and, if the light was allowed to play over the bladder, it invariably caused prompt voiding of urine. It is necessary, however, to state that at the same time the case was given very thorough anti-rachitic treatment, by means of liberal diet and other remedies; but this apparently was not effectual until supplemented by the application of the arc-light and the X-rays.

For bad hospital cases the treatment by the X-rays or other forms of light, in skilled hands should prove of distinct value; and, in the summer or sunny days, the exposure of the whole body to the action of the sun's rays, passed through coloured glass, may also become a recognised form of treatment in certain cases of rickets. Light is a great stimulus to growth and nutrition; and it is a well-known fact that light which is chemically active causes dilatation of the capillaries, and imparts a stimulus to the whole living organism, and for this reason ought to influence for good the retardation of development that has occurred in rickets. But, whenever possible, "sun baths" ought to be preferred to treatment by any artificial light in closed chambers, and their salutary effect increased by giving the patient, at the same time, an abundance of fresh air, whenever possible, out of doors.

#### D R U G S.

In discussing the treatment of rickets by means of drugs, it is assumed that the case is being fed on an appropriate diet, and that the general hygienic appointments have received due attention. The greater part of the battle against the disease must be fought by measures introduced to ensure adequate treatment by the promotion of the child's nutrition with good food, fresh air, and a healthy environment. In any attempt made to obtain the best and most permanent results, drugs, though they afford valuable aid, should only be used as auxiliaries to better and more effective methods. Nevertheless, there are various indications in the course of the disease for the use of certain drugs, which are prescribed so constantly that a few medicines, - notably phosphorus and cod-liver oil, - have become regarded as almost specific remedies in the treatment of rachitis.

The treatment with drugs may be conveniently considered under the following headings:



## I. The gastro-intestinal tract.

(a) The elimination of toxic products.

(b) The reparation of the digestive tract, and the stimulation of its functions.

## II. The building up of the general nutrition, and the restoration of nervous tone and stability.

(a) Anaemia.

(b) Constipation.

(c) Builders and reconstructors of the tissues of the body, especially of bone and the nervous system.

(d) The increase of muscular power.

## III. The various concurrent disorders, and the complications during the course of the disease.

## I. THE GASTRO-INTESTINAL TRACT.

(a) ELIMINATION OF TOXIC PRODUCTS.

If rickets is due to a toxic absorption from the intestinal tract, the earliest treatment by means of drugs must be directed towards cleansing and clearing the canal of poisonous products, and at the same time to check, as far as possible, any further production of toxins and fermenting gases by the administration of antiseptic remedies.

The safest drug for this purpose is undoubtedly castor-oil, given in one large dose, if required to act speedily, or, for mild and continuous treatment, fractional doses several times a day; and its value may be enhanced by combining with it some antiseptic, - such as salol, salicylate of soda, boric acid, or resorcin. Some writers recommend a morning dose of twenty or thirty drops of castor-oil to be given for several days, until the motions show signs of improvement. In the diarrhoea of rickets, if the motions contain much slime, with undigested matter, and are extremely offensive and acid, five minims of castor-oil, combined with tincture or syrup of rhubarb - given thrice daily - clears out decomposing matter, and acts as an astringent.

A similar effect may be obtained by giving small doses of calomel (gr. 1/10 - 1/6) several times a day. Grey powder is also of service; it may stimulate the liver and blood-making glands; and frequently children, even when not syphilitic, improve under its influence, and gain weight and colour.

After a time, the aperient may be dispensed with, or only given occasionally, and intestinal antiseptics taken until fermentation has been checked and the fresh production of poisons prevented. At the present time the list of these remedies is considerable, but they are not always satisfactory in action, and their use seldom free from danger. For prolonged use the writer is of the opinion that better results ought to be obtained from the use of lactic acid obtained by feeding with butter-milk, or milk prepared with Lactobacilline ferment, than by dependence upon chemical disinfectants.

Naphthalin is a powerful antiseptic, and quickly lessens the foetor of the stools and urine; it is highly recommended by Angel Money, who describes rickets

as the great slime-producer of vesical and colonic membrane, the chief parent of stinking stools and foul urine. He prescribes naphthalin in cachets, two grains for each year of the infant's life, twice or thrice daily, to alleviate the path to recovery while dietetic errors are being rectified. The taste and odour of this drug are very unpleasant, but can be disguised by dispensing with oil of bergamot and infusion of chamomile (naphthalin gr.i; ol.bergamot.m.ss; infus.anthemidis 3ii).

Naphthalin ..... gr.v.  
Mucil.Acaciae ..... 3i.  
Ol.Bergamot. .... m.iii.  
Infus.Anthemidis ad 3ii.  
3i t. d. s.

Or

Naphthalin ..... gr.i.  
Ol. Bergamot ..... m.ss.  
Sacchar.Alb .... ad gr.vii.  
Mitte pulv.x in charta cerata.  
Pulv.i, omne iii horis.

Good results may be obtained from the mixture of free chlbrine gas - so highly praised by Burney Yeo in the treatment of enteric fever; but it is not a palatable remedy for use with young children.

Urotropin is a valuable drug for the correction of the putrefactive intestinal processes common in rickets. Under its influence, indicanuria is diminished or removed, and a general improvement established in the patient's condition.

If diarrhoea is excessive with offensive stools, salicylate of bismuth, combined with benzonaphthol, sal ol, carbolic acid or resorcin, are appropriate remedies.

Grey powder can be usefully combined with an antiseptic and small doses of Dover's powder, if peristalsis is excessive. This combination may prove very effective in cases of lenteric diarrhoea when the food passes rapidly through the intestines, immediately it is taken, without any attempt being made to digest it. As far as possible, it is advisable to have these remedies dispensed without any mucilage, as this excipient is liable to increase the tendency to fermentation.

In cases where vomiting complicates the diarrhoea, guaiacol, creosote, and creosotal may be given a trial; and the last-named may prove very effective if catarrh of the bronchi or lungs is also present. In stubborn cases the effect of these remedies may be assisted by lavage of the stomach and the lower bowel or colon.

#### (b) REPARATION OF THE DIGESTIVE TRACT AND STIMULATION OF ITS FUNCTIONS.

The appetite in rickets is poor, capricious, and often excessive - owing to the presence of gastric catarrh, fermentation, and hyperacidity. The dyspepsias of rickets are frequently due to excess of acid in the stomach; and it is often necessary to neutralise the free acid by the administration of alkalies before meals, and in severe cases between meals also.

For this purpose alkaline mixtures may be given, containing bicarbonate of soda, carbonate of magnesia, aromatic spirits of ammonia, with spirits of chloroform, or some carminative; and, if there is gastric irritation, some preparation of bismuth may also be added. If a sweetening agent is required, glycerine should be used

in preference to sugar or syrups.

Later, the vegetable bitters, such as gentian and calumba, may be added, together with nux vomica if the appetite is impaired and the digestion feeble.

Rhubarb, - in the form of powder, tincture, or infusion, - is a valuable remedy; and, by virtue of its astringent action, it corrects the tendency to an excessive secretion of mucus.

If there is a deficient secretion of hydrochloric acid, sodium chloride or ammonium chloride will act as stimulants; the former drug seems to exert a favourable influence in assisting the increase of body weight, and should always be given freely to rickety children.

So soon as the gastric catarrh has been corrected, remedies stimulating the stomach and promoting secretion are more serviceable; and they may be combined with digestives such as pepsin or taka diastase. Various combinations, - varied according to the organ or function requiring stimulation, may be given a trial. Dilute hydrochloric acid (M.i - iii), with liquor pepsinae (m.xx - 3ss), or dilute phosphoric acid or nitrohydrochloric acid with liquor euonymin. et pepsin. (m.xv - xx), may be given alone or in combination with nux vomica or strychnine and vegetable bitters; Peruvian bark, or quinine may be added to increase the tonic effect of the mixture; and their action may be made more effective and beneficial by combining them with a tonic laxative, such as the aromatic syrup of cascara.

Aubrey Husband (Med. Press & Circ., 1903) obtained very good results from the use of five-grain doses of Lactopeptine in the treatment of rickets with dyspepsia and diarrhoea. He quotes two cases, - aged respectively two and three years, - both of which were doing badly; but, after Lactopeptine in five-grain doses had been given three times a day after meals (in the hope that it would make the food more digestible), both children made rapid improvement. The good results may be partly ascribed to the supervision and regulation of the meals and habits of the children. The writer has occasionally used Lactopeptine with good results in the convalescent stage following prolonged infantile diarrhoea.

If flatulence is a distressing symptom, it may be relieved by a mixture containing resorcin or carbolic acid, combined with strychnine and the compound tincture of cardomoms, - though frequently an alkaline mixture composed of bicarbonate of soda with aromatic spirits of ammonia and aniseed-water, or a portion of a soda-mint tabloid, will be sufficient to relieve discomfort.

## II. THE BUILDING UP OF THE GENERAL NUTRITION OF THE BODY, AND THE RESTORATION OF NERVOUS TONE AND STABILITY.

### (a) ANAEMIA.

The anaemia of rickets, - so early a symptom of this grave disorder, - may prove very intractable; and it must be largely combated by strict attention to the diet, which should contain an adequate amount of proteid. The patient must also lead an out-door life, in order that an abundance of fresh air and sunlight may be obtained. The addition to the food of animal broths, peptones, raw meat-juice (freshly prepared), Virol, or some other preparation of bone-marrow (glycerinated extracts), or haematogen, may alone be sufficient to



effect a cure.

If constipation is also present, this must first be corrected before an hope of curing the anaemia can be entertained. In some cases small doses of grey powder act in a very favourable manner, and stimulate the blood-glands to produce a better quality of blood, with a greater percentage of haemoglobin.

All casual conditions must be treated and corrected before the employment of haematinic remedies. It is useless to give iron or other tonics, unless the gastric catarrh and other troubles of the digestive tract have been set in order. If catarrh of the stomach is present, iron will be badly borne; but, if the anaemia is due to a general condition of malnutrition, one of these preparations will improve the entire tone of the system, and the stomachic disorder at the same time. Infants who have suffered from chronic diarrhoea often tolerate iron badly, and great care must accordingly be exercised in its use; a mild preparation should be selected, and the initial doses should be small.

In cases of gastric irritability, the neptonate of iron, with or without manganese, - the liquor ferri dialysatus, the saccharated carbonate or the ammoniated citrate of iron - all preferably flavoured with glycerine - are usually well borne, and bring about improvement.

The syrup of the iodide of iron is well tolerated, even by young infants; and it may be combined with the compound syrup of the hypophosphites or the glycero-phosphates. It is specially indicated when there is glandular enlargement; and the iodine, which is set free from the iron, often acts as an antifermentative in the stomach. The dose is about one minim for each month of the infant's age, up to about ten drops as a maximum dose, given thrice daily after food.

Cheadle does not approve of the use of iodide of iron in the treatment of a disease of degraded nutrition like rickets; it has been known to produce purpura and great debility, and he considers that it may prove harmful from its depressing and blood-deteriorating qualities.

A combination of thyroid extract and iron is useful in cases of extreme anaemia with enlargement of the spleen:

R/

Ext. Thyroid. .... gr. ss.  
Ferri Carb. Sacch. ... gr. iiii.  
Ft. pulv.

Sig. - Ter in die.

G. Carpenter (Brit. Jour. Childn. Dis., Vol. i, p. 301) highly praises an organic preparation of Iron Vitellin (Oviferrin), which acts very rapidly upon the blood, and also upon the subjective and objective symptoms. In a case of rickets (aged one and a half years) with anaemia and enlarged spleen, on drachm doses given thrice daily, the haemoglobin rose from 50 to 80 per cent. in four weeks. In two other cases of rickets, the haemoglobin rose rapidly in a few weeks under treatment with this ferruginous preparation.

Ovivitellin has distinct advantages over inorganic and other preparations of iron; it produces a rapid increase of the red corpuscles and of the haemoglobin,

improves the appetite, does not disturb digestion, and does not give rise to constipation. It has a good effect upon the general condition of the body. It is almost tasteless, it is palatable, and is well borne, even in large doses, by children.

The effect of the preparations of iron may often be considerably enhanced by the addition of small doses of arsenic or strychnine.

Arsenic appears to be of especial value in cases of slow convalescence, of those with glandular enlargement; and it also acts as a powerful nervine tonic. It has been recommended by Louis Starr (Diseases of the Digestive Organs) to check uncontrollable vomiting of chronic gastric catarrh. He prescribes half a minim of the liquor arsenicalis, with alkalies and aromatics, thrice daily to a child of three months. If there is enlargement of the spleen and of the lymphatic glands, arsenic, given three times daily in small doses of Fowler's solution (m.  $\frac{1}{2}$  - i), may cause great improvement. Children often bear arsenic better than adults; but its use must ~~not~~ be discontinued, if toxic symptoms, - such as conjunctivitis, oedema of the eyelids, or gastric catarrh, - make their appearance. The liquor arsenicalis is the most useful preparation; but the arsenic may be given, if preferred, as Levico Water.

#### (b) CONSTIPATION.

The constipation of rickets is largely due to the general feebleness of the muscular layers of the intestines, and the atony of the abdominal walls. It should be treated to a great extent by alteration of the diet, and by improving the general health and condition of the rickety child. As far as possible, drastic purgatives should be avoided, and resort mainly had to tonic laxatives, - such as cascara suitably combined, when necessary, with aloin, belladonna, and strychnine.

For the relief of chronic constipation Cheadle recommends the use, over a prolonged period, of a mixture of salines with cascara, keeping the motions fluid for some little time. He gives five to ten grains of carbonate of magnesia or phosphate of soda twice daily, to which may be added, if required, cascara, belladonna, and strychnia. Massage and electricity, if correctly applied, assist greatly the action of drugs in the cure of chronic atonic constipation.

If associated with anaemia, sulphate of magnesia and iron, or the syrup of the iodide of iron, together with the administration of some form of beef-juce, will cure the constipation and other symptoms. The constipation of rachitis is often very slow to respond to treatment; and drugs may have to be given over a prolonged period, and the diet modified in all its constituents. The constipation must always be regarded as a symptom of the atonic condition of the muscular system, as well as general malnutrition; and the early treatment should be directed towards improving the asthenia before attempting any permanent cure of the digestive disorders produced by the rachitic disease.

#### (c) BUILDERS AND RECONSTRUCTORS OF THE TISSUES OF THE BODY, ESPECIALLY OF THE BONE AND NERVOUS SYSTEM.

In rickets, the ravages of the disease are principally observed in the osseous and nervous system; and, in prescribing drugs for the improvement of the general nutrition, special remedies may be necessary

for the repair and reconstruction of these more damaged parts.

Lime is a constituent of bone; and fats, phosphorus, and lecithin are found in the nervous elements: these are the remedies that naturally suggest themselves for the repair of these wasted and disorganised tissues. Theoretically, lime is given to provide a supply of calcium to renew the waste, and assist in the formation of new bone; it has been largely used in the treatment of rickets in the hope that it would replace the deficiency of this important element in the decalcified osseous tissues. Almost all the calcium in the human body is deposited in the bones. The rickety child is probably receiving an ample supply of calcium, but it is unable to make use of it: for, assuming that a patient has been fed on cow's milk, this fluid contains more calcium than human milk, - so that the system is receiving a greater amount than it can efficiently deal with, and the excess is eliminated in the faeces and urine.

Jacobi considers that, so long as the food contains plenty of calcium and phosphoric acid, there is no indication for introducing it in the form of medicine. Good and well-cooked oatmeal porridge, for this reason, is a valuable food in rickets.

It is possible that some of the beneficial action of calcium, when employed as the phosphate, is due to its action as an antacid: for it is split up in the stomach into free phosphoric acid and lime, which neutralises the acids present in this organ.

According to Stoeltzner, the use of calcium - especially the chloride - increases the irritability of nervous tissues, and therefore its use is contraindicated in rickets, - particularly when complications, such as laryngismus, are present.

At one time lime-water was largely used in the treatment of rickets; it is quite ineffective as a therapeutic agent, and the calcium, if it is to be assimilated by the system, ought to be prescribed in the form of the phosphate.

The salts of calcium are largely used as tonic remedies; but the good results obtained cannot, however, be ascribed to the calcium, but rather to its effective combination with other drugs. Calcium is usually prescribed in the form of the phosphate, hypophosphite, lactophosphate, or glycerophosphate; and to the calcium base are usually added those of sodium and magnesium. Not infrequently the value of the preparation is increased by small doses of iron, quinine, and strychnia.

Goodhart expresses a preference for the syrup of iron and calcium lactophosphate, though some writers consider the preparation valueless in rickets.

The writer finds that a combination of the compound syrup of phosphate of iron with the syrup of calcium lactophosphate, flavoured with syrup of orange, makes a palatable preparation readily taken by children; it improves the appetite in cases of rickets, and hastens the convalescence of acute diseases. Other cases do better with a stronger preparation compounded from the triple syrups, and used in varying proportions - viz.: syrup ferri phos. co., syrup hypophos. co., and syrup ferri phos. c quinia et strychnia, - aa., syn. - syrup triplex.



If a special nervine tonic is required, the Easton's syrup can be replaced by the compound syrup of the glycerophosphates, which are often better assimilated; and, if anaemia is a marked symptom, a glycerinated extract of bone-marrow ~~may be~~ added to the mixture.

The treatment of rickets with the phosphate of calcium would seem particularly applicable after the development of the bone lesions; it is scarcely necessary to emphasize the need for treating rickets, if seen in its earlier stages, in as thorough a manner as possible, in order to prevent the development of the skeletal changes.

The value of calcium and the compound syrup of phosphates and hypophosphites is much increased by the simultaneous administration of cod-liver oil; and these remedies are often combined in a single prescription. Cod-liver oil is to be recommended ~~principally~~ as a fat food; but, by reason of the presence of certain animal extracts, - which are supposed by some to give it special therapeutic virtues, - it is also classed as a drug.

It is ~~important~~ to give only small quantities of cod-liver oil at the beginning of its exhibition - especially to young infants, who, if under one year of age, tolerate it badly. Usually the ~~initial~~ dose should be from five to twenty drops; and the stools should be daily inspected for its presence, and, if this is noted, there should be a reduction of the dose or the discontinuance of the drug for a time. Rickety children are only too frequently drenched with cod-liver oil and Parrish's Chemical Food, which they can only imperfectly assimilate, - with the result that the stomach is still further disordered, and progress towards recovery indefinitely delayed. The oil should never be given if there is any evidence of gastric disturbance.

Cod-liver oil may be given plain or in an emulsion with lime-water and milk-sugar, or flavoured with some aromatic water or wine. In some cases a single dose at bedtime causes less discomfort than frequent doses during the day. It may be better borne, if given with a few drops of ether or alcohol; the presence of the ether causes a stimulation of the movements of the stomach, the expulsion of the oil into the duodenum is facilitated, and to some extent it also prevents unpleasant eructations. The oil may be more readily absorbed if given in the form of an emulsion, which should always be freshly prepared, and not prescribed in the form of the proprietary article, even though some such preparations are quite reliable and of considerable value. The yolk of an egg and brandy are added to some emulsions, the same being of considerable utility in the treatment of rickets.

The administration of cod-liver oil with a malt-extract is a combination which is readily assimilated, and is both a fatty and a carbohydrate food. This combination is also often prescribed with the addition of the hypophosphites of sodium, magnesium, and calcium, with iron, quinine, or creosote. Cod-liver oil is frequently made the vehicle in which to administer free phosphorus.

An example of the combination of oil with various other remedies is the Mistura Rachitis of the Edinburgh Children's Hospital. Each drachm contains:

Ol. Morrhuæ,  
Syrup. Calcis Lactophos.,  
Aq. Calcis, ..... aa m.xviii.  
Sod. Hypophos. .... gr.i.  
Mucilaginis ..... m.viii.  
Ol. Cassiae ..... m. 1/9.

In the case of weakly infants when the oil is badly digested, it may be administered by inunction; it is absorbed to some extent through the skin, and its presence can later be detected in the stools. There is often considerable improvement in the nutrition of infants treated by this method.

Cod-liver oil is of considerable value in the treatment of the respiratory disorders of rickets, which improve more rapidly of this drug is employed than with routine cough mixtures; it also helps to increase the powers of resistance of an infant against disease, and thus minimises the risk of infection from tuberculosis.

In the treatment of rachitis F. Carbonel y Soles (Arch. de Gin. Obstet. y Ped., 1903, Vol. xvi, No. 18, p. 401) makes use of the antiseptic action of creosote, and combines it with cod-liver oil. The creosote prevents fermentation, and promotes the nutrition of the tissues; with or without cod-liver oil, it is a valuable remedy for the treatment of chronic intestinal catarrh - so common a disorder in rickets. The same author usually employs guaiacol or tannate of creosote for patients suffering from chronic diarrhoea. If the age of the patient, hot weather, or severe diarrhoea contraindicate the use of cod-liver oil with creosote, he advises the use of creosote tannate in daily doses of one to five centigrams, combined with the elixir of pepsin or glycerophosphate of sodium in syrup and water. This stimulates the appetite, renders the stools less offensive, and increases the weight of the body in a few weeks. The urine should be watched; and lesions of the kidney contraindicate its use. This writer finds an emulsion of cod-liver oil, combined with lactophosphate or hypophosphate of calcium, a valuable remedy in athrepsia and rickets.

Extract of Malt and Maltine. - These preparations are frequently employed in the treatment of rickets, generally in conjunction with cod-liver oil. Their chief value lies in the presence of a diastatic ferment; they must be regarded largely as foods which are readily absorbed by the stomach and intestines. Some of the preparations of malt contain a small percentage of alcohol, which is added as a preservative, and also to thin the thick and viscous fluid.

The use of extracts of malt is contraindicated if there is already an excess of starch or sugar in the food; but, in cases of malnutrition - especially when there is an inability to digest carbohydrates - they may be of considerable service: though, in the majority of instances, it is advisable to add the malt-extract direct to the starch food, and give it as a dextrinised gruel or food, the maltose thus formed being finally

absorbed by the tissues as dextrose. It is an excellent vehicle for the administration of hypophosphites, glycerophosphates, or cod-liver oil, and, if necessary, such antiseptic remedies as creosote.

Hitchinson (Patent Foods and Patent Medicines, p. 17) considers that the malt-extracts are valued too highly as remedial, both by the medical profession and the public. He points out that, unless the diastatic action is required, equally good results can be obtained from the use of honey; and that, on account of the care involved in the preparation of the malt-extracts in order to prevent the destruction of the diastatic ferment, its cost is out of proportion to its true value as a food, - one pound of malt-extract costing three shillings, whereas a pound of honey only costs ninepence, and is the better source of sugar of the two.

**Phosphorus.** - This drug was first used in the treatment of rickets by Trousseau, who prescribed it as phosphorated butter. It is also used by Hahnemann. It is very highly praised by Kassowitz, - especially for the cases with craniotabes, - and he regards the drug as a specific remedy for the treatment of rickets. He states that it hastens the closure of the anterior fontanelle, cures craniotabes, prevents laryngismus, and brings about a rapid cure. Jacobi confirms Kassowitz's conclusions, and finds the drug of especial value in cases with craniotabes; he has also seen great benefit from its use in acute rachitis with epiphysitis, general feebleness, diarrhoea, and symptoms of scurvy.

Its therapeutical value in rickets is largely based upon the fact that fractures of the bones heal more rapidly, and better callus is formed, if phosphorus in minute doses is administered during the progress of reparation, than without the aid of the drug. This was experimentally proved by Wegner, who fractured the bones of animals, and then fed them for a time on minute doses of phosphorus.

It is extensively employed by the continental physicians, who obtain good results from the use of the drug and are enthusiastic in its praise; it is also used to some extent in England, where, however, greater reliance is placed upon dietetic and hygienic remedies, and the drug is not regarded with equal favour by all authorities. Phosphorus often enhances the value of cod-liver oil in cases of rickets. It must not be used if there is any derangement of the stomach, especially of a catarrhal nature; and, as this is of frequent occurrence in rickets, the drug should be kept in reserve for severe and intractable cases. Phosphorus should be regarded chiefly as a bone-repairer, a promoter and hastener of new growth, and as a nervine tonic. It is of especial service in the treatment of laryngismus, when it acts quickly and in a similar manner to arsenic.

In the case of children, the initial dose of phosphorus should be small,  $1/600$  to  $1/200$  of a grain, pro dosi, for a child of from one to five years of age, though some authorities give as much as  $1/220$  of a grain. The average dose is  $1/200$  of a grain thrice daily, which has been given for several months without producing any unpleasant results. It can be given dissolved in oil;



this vehicle can also be used as the flavouring agent, as in the case of almond-oil, or as a nutrient when the phosphorus is dissolved in lipanin or cod-liver oil. The mixture can be made more palatable by the addition of oil of lemons:

R/

Phosphor. .... gr.ss.  
Ol. Limonis ..... m.ii.  
Liparin ..... 3iii.  
(Vel Ol. Morrhuæ.)

Sig.- Half a teaspoonful twice daily,  
after meals, for a child of two  
years of age.

Illustrative Cases.- The following cases show the value of the administration of phosphorus when there are special indications for its use:

Case 1.- F. F., a child of well-to-do parents, suffered from repeated attacks of bronchitis. He was two years of age. There was a typical rickety head, widely-open anterior fontanelle, beaded ribs, enlarged epiphyses of wrist and ankles, and very deformed tibiae. He was always getting bronchitis. He was put on an appropriate diet, together with cod-liver oil. Under chloroform the legs were straightened, and splints applied for a period of three months. Nine months later he was again seen, and the deformities were as bad as ever. The surgical treatment was repeated, and he was ordered phosphorus, gr. 1/200 in one-drachm doses of cod-liver oil, thrice daily. The splints were removed in three months. When last seen ~~five~~ months later, the tibiae were perfectly straight, and there appeared to have been no recurrence of the deformity.

Case 2.- S. N., a child aged six years, had a double osteotomy of the tibiae performed. Both wounds healed perfectly without suppuration, but the tibiae refused to unite. The ends were rubbed together, but still union failed to take place. The child was then put on glycerophosphate of lime and cod-liver oil, and in three weeks the legs were put up in plaster of Paris splints. When these were removed, at the end of a month, it was found that firm union had resulted.

Holt has been unable to satisfy himself, after several years of trial, that in a great majority of cases phosphorus had any decided influence on the disease, though he agrees with certain continental authorities that the best results are seen in the early cases - especially where there is craniotabes and marked nervous symptoms.

Cheadle has never found it necessary to use phosphorus in the treatment of rickets, as he has found strict attention to the diet and hygiene usually amply sufficient to effect a cure; and Henoch, Monti, and Heubner all appear to distrust the treatment of rickets with phosphorus.

Dedelé (Riv. di Clin. Ped., Jan. 14; Brit. Jour. Childn. Dis., Vol. i, p. 285) has reported six cases in which improvement followed the use of phosphorus; and he believes that it acts by neutralising the toxic products of the intestinal tract which have infected the osseous and nervous systems and thus produced rickets.

After a month's treatment, there was great improvement in the hardening of the bones, the eruption of teeth, and the ability to walk; and the conditions of laryngeal spasm, hyperaesthesia, and instability were greatly alleviated. He gives  $1/200$  gr., in almond- or cod-liver oil, twice a day.

Concetti (Allg. Wien. Med. Zeit., Jan. 27, 1903) holds that more care should be exercised in the preparation of phosphorus mixtures for use with rachitic children. If badly compounded, the phosphorus and the oil do not mix thoroughly, and there is a want of uniformity in the amount of the dose taken. Failure to shake the bottle, when only the last few doses remain therein, may leave a concentrated amount of phosphorus at the bottom, which may cause gastric disturbances, fatty degeneration of the liver, or even death. He advises a solution of phosphorus in oil prepared as follows: A small quantity of phosphorus is dissolved in ether, and mixed thoroughly with almond-oil: to this is added cod-liver oil, and the mixture is put on a water-bath and kept at a warm temperature. By this means the phosphorus is entirely dissolved, and the ether eliminated. He recommends a proportion of 1 c.c. of phosphorus to 100 grm. of cod-liver oil; the solution should be kept in small airtight bottles, and must be thoroughly shaken before administration. The dose given is  $1/20$  centigram morning and evening, before meals in a teaspoonful of oil (Riv. di Clin. Ped., Jan. 1903, p. 24). He does not believe that the beneficial effect of the treatment is due to the hygienic measures adopted at the same time: for, in dispensary work, where the results of the phosphorus treatment can be best observed, the hygienic measures which are recommended to the mothers do not amount to much and also work slowly, while phosphorus produces very rapid results. He strongly urges the use of this method of treatment in rachitis, and thinks that its efficacy cannot be disputed.

P. W. Nathan's experiments do not support Concetti's enthusiasm and advocacy for the claims of phosphorus in the treatment of rickets. He treated 477 cases of rickets for a period of one month: of these 150 were treated with phosphorus, 50 were given cod-liver oil, 150 received calcium phosphate with sodium chloride, and 127 received no medicine - all cases being kept on a uniform modified milk-diet. The percentage of improvement varied - being somewhat higher without medication, and lowest with the exhibition of phosphorus.

The treatment of this disease with so dangerous a drug as phosphorus is not without risk; and cases have been recorded, in which death from phosphorus-poisoning has taken place; Nebelthan, for instance, has reported the death of a well-developed child of two years, after taking only 3 milligrammes of the drug in the course of sixty hours.

H. Leo also reports two cases of rachitis, treated with phosphorus, dying with toxic symptoms; the dose in each case had been 1 milligramme daily - one child taking it for fifteen days, and the other for six months. In both cases widespread fatty degeneration was found. Our author does not consider (Jahr. f. Kinderh., Vol. liv, 1901) that any conclusive proof has been offered of the specific action of phosphorus in rickets.

Ungar criticises these cases, and is doubtful if the phosphorus was the true cause of death. He finds the drug a valuable remedy, and gives 1/220 gr. daily dissolved in almond- or olive-oil. The drug, in his opinion, is **especially** valuable for arresting the laryngismus of rickets.

Several writers report favourably upon the results obtained with Protylin and Fersan, which are preparations of phosphorus combined with albumin.

M. v. Bilgorajski (Wien. klin. Rund., 1904, Nos. 11 & 12) strongly recommends the use of Protylin, which is well borne and can be given in milk or soup. It is also made up with iron or other combinations of medicaments, and is an almost odourless and tasteless preparation. He has given it in thirty cases, adults and children, and advises its use in rickets, scrofula, and osseous affections; and, if combined with iron, it is a valuable remedy in marked anaemia. He gets better results with iron and bromides, when they are used combined with protylin, than when these drugs are used alone.

It is well known that the mineral elements which take part in the processes of nutrition are not absorbed, - so that, in the majority of instances, when introduced into the system, they only throw useless work on an organism that is unable to assimilate them or derive benefit from their use. Therefore, owing to this inassimilability of the phosphates, - so largely used in the treatment of rickets, - has proved unsatisfactory and almost useless: for they only lead to an increase of waste products, which throws extra work upon a feeble digestion and a system debilitated by disease.

It has been shown by Bunge that, unless the mineral matters are converted into an organic form by being elaborated by the living organism, they cannot be assimilated or utilised in the human body.

Many attempts have been made to produce natural phosphates, by extracting them from vegetables, milk, or animal matter. One of these vegetable organic phosphates is named Phytin. This is a new natural organic phosphorus, and is prepared from the seeds of plants. It is manufactured by the Society of Chemical Industry in Basle, who claim that it contains 22.8 per cent. of phosphorus in a completely assimilable and non-poisonous form. It is described as an acid calcium and magnesium double salt of the new phosphorus principle discovered in plants, which is stored up as a phosphorus reserve substance, in all seeds, tubers, and rhizomes. Phytin therefore contains organic phosphorus as it naturally occurs in food, and should be easily assimilated by the body, and increase tissue metabolism.

Lecithin only contains 3.84 per cent. of phosphorus, mainly as glycerophosphoric acid; but it is combined with a toxic base, chlorine or newwine, and further contains no mineral bases, - such as lime or magnesia, - and with these disadvantages should prove less useful than an organic compound such as Phytin. It is also very costly to produce, and this prevents its use to any very great extent in medical practice.

Gilbert and Posternak show that Phytin heightens metabolic changes, promotes the nutrition of cells and tissues, improves the appetite and the state of the blood, and increases the body weight.



Fortosan is a neutral soluble preparation of Phytin combined with milk-sugar, and is recommended for children under two years of age. It has a similar therapeutic action to Phytin: for it increases the appetite, and stimulates the growth and nutrition of the tissues. Fortosan should prove a valuable phosphorus combination to employ in the treatment of rickets, and, being soluble, can be given in the milk or food of the infant. It is also an inexpensive remedy - a box of forty tablets costing about one shilling and sixpence.

The glycerophosphates are now largely used in general medicine - their special indications being neurasthenia, anaemia, rickets, and diseases of debility and malnutrition. Glycerophosphoric acid, being bibasic, forms acid and neutral salts - the acid glycerophosphates alone being used when given by the mouth, the neutral salts being reserved for hypodermic medication. The acid glycerophosphates are amorphous, hygroscopic, very stable, and are readily soluble in water.

The glycerophosphates possess marked advantages over many of the other phosphorus remedies; their chemical composition is definite, they provide - like neutral phosphates - phosphorus in an organic and easily assimilable form, and they are readily absorbed into the tissues. They may be regarded as true builders of cell tissue, and their tonic and stimulant action is specially directed towards the osseous and nervous systems. During their administration the acidity of the urine is slightly increased, but the urinary phosphates remain stationary - showing that the glycerophosphates are absorbed by the organism. The acid glycerophosphates have a marked cholagogue action, and favourably influence cases of dyspepsia with hyperacidity and defective action of the hepatic functions. These acid salts prove of great value in all nutritive disorders, usually associated with a drain of mineral matter from the system, which call for treatment with some form of phosphates; or in diseases, such as rickets, in which, in addition to the loss of mineral matter, there is an increased elimination of phosphates. The mineral constituent most deficient in rickets is calcium, and the glycerophosphate of lime is therefore specially indicated; and, if there is marked anaemia, the glycerophosphate of iron may be given in combination with the calcium salt.

In general practice, a combination of several of the acid glycerophosphates is usually prescribed; a formula in common use, suggested by Professor Robin, is the glycerophosphates of lime, soda, potash, magnesia, and iron, with small quantities of tincture ignatia amara, and the tincture of kola. If flavoured with syrup of cherries, this makes a very palatable preparation, and is readily taken by children. The acid glycerophosphates are a valuable addition to the drugs employed in the treatment of rickets, and ought in a large measure to replace free phosphorus, which is an unstable preparation, and has the great disadvantage of being more toxic in its action, and, if used for any length of time, is apt to become an irritant of the alimentary canal, and cause disorder or even fatty degeneration of the liver.

There is little doubt but that free phosphorus is a valuable remedy, and that striking results have been

obtained from its use in rickets. It is, however, not advisable to employ it in a routine manner in all cases, but, in rickets with severe bony deformity resisting treatment or relapsing after proper correction by surgical operation or in cases of persistent laryngismus not responding to ordinary remedies, phosphorus should always be given a trial.

The restoration and invigoration of the nervous system can be assisted by the administration of Tonic and stimulating drugs acting upon the nerve elements, - such as arsenic, phosphorus, and strychnine, - or by the administration of remedies containing the chemical constituents present in the brain and spinal cord, of which the various glycerophosphates and Lecithin are notable examples - these last-named drugs being true reconstituents and foods to the various wasted and hyperexcitable cells and tissues. A combination of both these classes of nerve remedies is often advisable, and together they may give better results and bring about a more rapid improvement. ~~Strychnine~~

Strychnine, in the form of liquor strychninae or tincture of nux vomica, may be slowly added to the acid or alkaline mixtures that may be used to correct the disorders of the digestive tract, and help to stimulate and promote healthy secretion. In the later stages, some form of strychnine may enhance the slower effects of the compound glycerophosphates.

First introduced into practice by Professor Robin of Paris, the glycerophosphates were shown to possess a distinct action upon the nutrition of the nerves; and their use is indicated in all cases showing enfeeblement of nerve power. Physiologically, their action is to accelerate nitrogenous metabolism, with the rapid assimilation of albuminoids and subsequent elimination of nitrogen. The glycerophosphates are often more readily absorbed and assimilated than the hypophosphites and the phosphates, with which they may be given in combination, or in a mixture containing malt-extract, cod-liver oil, or bone-marrow - to which, if necessary, are also added quinine, iron, or strychnine.

Sanatogen is a preparation containing 5 per cent. of sodium glycerophosphate in casein of milk. It is white powder, which can be made into a paste and mixed with the food; and in some cases it is a simple and effective method of administering a preparation of the glycerophosphates.

Fischer and Beddies of Berlin (Allg. med. Centralbl. Ztg., 1899, No. 25) give instances showing that, even in cases of disease, Sanatogen completely disappears from the stomach half an hour sooner than egg albumin or casein dissolved by a sodium salt.

Schwarz (Deut. med. Woch.) also speaks highly of results obtained from Sanatogen in rickets. The appetite improved, the weight increased, diarrhoea - when present - rapidly disappeared, the rachitic processes were checked, and the bones became firmer and more resistant.

David Walsh (Med. Press & Circ., Nov. 2, 1904) found that this preparation gave good and immediate results in the case of children suffering from wasting diseases

- especially when associated with diarrhoea; and James Burnet (Practitioner, Oct., 1905) considers that it is of considerable value in infantile atrophy, and quotes two cases which showed marked improvement and a slight increase in weight under its use.

The writer has used Sanatogen more largely in cases of neurasthenia than in rickets, and does not find it well tolerated, and has observed that it occasionally causes indigestion. It seems a helpful remedy in cases of rickets when there is difficulty in the digestion of the casein of milk; and this combination appears to be useful as a tonic, and affords special assistance to starved and debilitated tissues by enabling them to absorb and assimilate nutriment much more rapidly.

Lecithin.— Pure lecithin is now also employed in practical medicine. It is a constituent of the brain, and is also found in the seminal fluid, the blood, most of the principal organs, and in the yolk of egg. In the intestines it is decomposed into stearic acid, glycerophosphates, and neurine. It produces marked increase in the body weight, and augments the number of blood-corpuscles.

The drug is usually administered by the mouth, though some authorities consider that it has a much more powerful therapeutic action if given by intramuscular injection.

Gölinger has administered lecithin in the form of chocolate tablets (gr. 5/6), which is a pleasant method of exhibition and particularly suitable for children. He has found it cause visible improvement in chronic affections, including rickets; and, by reason of the phosphorus it contains, it exercises a favourable influence upon the processes of metabolism.

Lecithin has been employed with success as hypodermic injections in the treatment of marasmus; but, in the case of children who are suffering from such chronic affections as rickets and whose nerves are so readily disordered, this method hardly recommends itself for serious consideration.

Serpens has introduced a preparation, named Bioplastin, consisting of lecithin emulsified with 0.75 per cent. of sodium chloride solution; it has been employed by Sicuriani (Rif. Med., 1904, No. 36; Merck's Repts., 1905, p. 124) by hypodermic injection, and is said to influence the general nutrition of patients - especially if suffering from nervous exhaustion.

A Migliaccio (La Ped., Oct. 1904; Brit. Jour. Childn. Dis., p. 138) employs this drug in the children's clinic at the University of Naples, and gives intramuscular injections of 30 centigrams of lecithin, made into an emulsion with normal saline solution, every other day. Under this treatment, there is rapid increase of body weight, an increase of haemoglobin (averaging 10 per cent.), and an augmentation of the number of the blood-corpuscles.

It improves the digestion, and thereby removes one of the greatest causes responsible for the production and the continuance of rachitic disease. It is of advantage to give lecithin, for the reason that the phosphorus in it is exhibited as an organic compound,



and by curing digestive disorders, it removes the main cause of the disturbance of the normal process of ossification. It does not produce intolerance or digestive disturbance which may occur when phosphorus is given, and therefore has a marked advantage over this drug.

G. Carrière (Gaz. des Malad. Infant., 1902, No. 21) recommends cod-liver oil as a means of treating rachitis, and gives the following formula:

Cod-liver oil (light-coloured) - 1 litre.

Lecithin of fresh eggs - 1 grm. 10.

This equals about 0.05 of lecithin to the teaspoon, and the dose is from one to four drachms. This preparation, administered to five rachitic children under two years, was followed by cured in from four to six months, and there were no relapses.

The simplest and often the best method of administering lecithin is to give the raw yolk of a fresh egg, which contains a large proportion of lecithin in an easily assimilable form. The writer's experience of lecithin is confined to a trial in a few cases of marasmus; the results were only partially satisfactory, though, while the drug was being taken, in some instances there was a temporary gain in weight.

(d) THE INCREASE OF THE MUSCULAR POWER.

The debility of the muscular system - so marked a symptom of rachitic disease - slowly yields under a careful regimen, which should include a generous diet, abundance of fresh air, baths, massage, and electricity; and it may also derive considerable benefit from the various tonic remedies prescribed for the general treatment of rickets - more especially from those drugs that are directed towards the improvement of the general nutrition, and the building up and stimulation of nervous tissue and energy.

Latterly, formic acid and the formates have been largely used in the treatment of muscular debility; they can be employed combined with the glycerophosphates, and several palatable and reliable preparations are manufactured by the best-known chemical houses.

Clément states that formic acid increases muscular power. It gives tone to the muscles, restrains muscular tremor, increases muscular energy, and abolishes the sense of fatigue. It improves appetite, mental and physical activity, and should prove of service in the muscular asthenia of rickets.

Small doses of the elixir of coca, combined with strychnia or other tonics, may be used with advantage for short periods, when muscular and cardiac weakness are marked symptoms.

Wm. Ewart (Brit. Med. Jour., 1906, p. 922) has had excellent results from adrenalin solution (m.  $\frac{1}{2}$  - 1 in a drachm of water), given three or four times daily on an empty stomach, in the treatment of the muscular asthenia of rickets.

In combating the malnutrition and the loss of tonicity of the muscles, too much reliance must not be placed upon drugs: for better and more permanent results are obtained by other methods, and by careful supervision of the child, its diet, and its environment.

### Treatment with the Extracts of Animal Glands.

The obscurity which overshadows the pathology of rickets, and the profound and far-reaching disturbances of nutrition of the body produced by this disease, has led workers on this subject to endeavour to find a solution of the problem through disorders, set up by disease or loss of function of one of the ductless glands; and they have administered various extracts of the active principles of these organs, with a certain amount of success, though no overwhelming evidence has accumulated to suggest that a specific remedy for rickets lies in this direction.

Heubner has obtained good results from the use of the thyroid gland; Mendel with thymus-extract; and Sweltzner from the extract of the suprarenal gland, - whilst, in other hands, preparations of bone-marrow have proved successful in the treatment of the disease.

#### Thyroid Gland.

The thyroid gland has been used in the treatment of rickets; but there is no reason to believe that it possesses any special value in this disease, and its cost would prohibit any prolonged use amongst the poor. It is possible that some of the cases benefited by its use were suffering from cretinism, and had developed rachitic symptoms.

Heubner, greatly influenced by the theory that the virtue of cod-liver oil lay in its organic extracts, gave thyroid-extract a trial in rickets, but was not satisfied that he perceived any benefit from its use.

Henoch advocated the use of thyroid-extract in advanced cases of rickets; but this view is opposed by Monti and other authorities.

Ausset (Brit. Med. Jour., Nov. 9, 1901) considers that the success of phosphorus depends upon the fact that it supplies a stimulus to development, which is wanting in rickets, owing to some failure in the function of the thyroid gland.

Extract of thyroid is rich in phosphates, and, therefore, according to this writer's statement, should be beneficial in rickets.

Koplik uses thyroid-extract in certain selected cases, usually when complicated with anaemia and enlarged spleen, but, as a rule, he combines it with iron. He finds that hospital cases do not do well under its administration.

The effect produced upon cases suffering from the absence of this gland, or from a deficiency in its function, would suggest that improvement ought to follow its administration in rickets. In cretins or athyroidic cases, the nutritive and gaseous exchanges recover their normal activity, the percentage of oxyhaemoglobin increases, and the processes of ossification are stimulated and energetically accomplished, and there is a greater power of bearing fatigue. On the other hand, if excess of thyroid is administered, it produces a train of symptoms that would prove distinctly harmful to a rachitic patient. Excess of thyroid-extract in the system would give rise to great nervous excitability, and general symptoms of vasodilatation, together with loss of weight, gastro-intestinal troubles, diarrhoea, and albuminuria.

it should be employed with the greatest caution in rickets: for it is a double-edged weapon, quite capable of producing harm, and not always certain of influencing the disease for good.

#### Thymus Gland.

Rickets being largely a disease of infancy and early life, it seems natural that observers should turn towards the thymus gland, in the hope of finding in this organ some clue to the pathology of the disease. The thymus is present in foetal life, and commences to atrophy from the second to the third year. If it persists, there may be some defect of the thyroid gland, and it has therefore been assumed that the thymus is complementary to the thyroid in function.

The thymus contains combinations of iodine analogous to those present in the thyroid-extract. It has been suggested that, by some internal secretion, the thymus exercises considerable influence on the development of bone, and that the enlargement of the spleen in rickets may be a compensatory hypertrophy - the spleen replacing some function of the thymus gland. The value of this theory, however, is to some extent discounted by the fact that the spleen is only enlarged in about 5 per cent. of the cases of rickets.

Basch (Jahr. f. Kinderh., Aug. 8, 1906) has removed the thymus from young dogs, and came to the following conclusions: that these animals, if deprived of the thymus, were smaller, less intelligent, and lively, and more easily fatigued; the bones of the extremities were softer and more readily fractured. Microscopically, the compact layer of bone was thinner in the diaphysis; the epiphyseal line was wider and more irregular; but there was no hyperplasia of lymphoid tissue.

Mendel was led to use an extract of the thymus gland, because of the similarity of symptoms in dogs from which the thymus had been removed; and also because Friedleben, in post-mortem examinations of all cases of rickets, had found this gland to be small and hard. He has treated more than one hundred rachitic children with thymus-extract during the last five years. At first the preparation used was the fresh gland, minced and made into a thick syrup, each child receiving as many grammes of fresh gland substance as he was months old; latterly, he has used tablets, giving six to twelve during the day, according to the age of the patient. No ill effects were observed: on the contrary, our author states that the rachitic process was favourably influenced in many cases, and a rapid and effective control established over the functional disturbances.

#### Suprarenal Gland.

Suprarenal-extract has also been given a trial in the treatment of rickets - more especially by Stoeltzner. He has used ordinary tablets of the gland, and a preparation called Rachitol (Merck). The latter seemed to have no influence on the disease, but some English tablets did good, though their effect was not constant.

Konigsberger (Munch. med. Woch., April 16, p. 627) cannot confirm Stoeltzner's estimate of the usefulness of the suprarenal gland in rickets. He began with a



daily dose of as many centigrams as the child weighed kilograms, and increased this up to double the amount, and even more. The substance had no specific effect on rickets, though the general health was sometimes improved by its action on the circulation and respiratory organs. He is of the opinion that the same results can be obtained with less expensive drugs.

Wm. Ewart (Brit. Med. Jour., 1906, p. 922), as before mentioned had found adrenalin of value, given in small doses, in the muscular asthenia of rickets.

A summary of the results obtained in the treatment of rachitis with suprarenal-extract is given by Stoeltzner. A favourable effect is observed on the general condition, on the profuse sweating and the nervous manifestations, and it is of especial value if craniotabes is present.

The suprarenal-extract has practically no influence on the enlargement of the epiphyses, the rickety rosary, or in cases of laryngismus, and it does not hasten the closure of the anterior fontanelle. Children regain rapidly the power of walking and running, the softness of their thoracic walls disappears, and there is eruption of teeth. The amelioration of the symptoms is most rapid during the first eight days of the administration of the drug, and the best results are observed during the first fortnight, but after this period there is only slow progress towards improvement. Suprarenal-extract may prove of value in special cases; but, as equally good results can be obtained with the use of cheaper and equally reliable drugs, its administration seems uncalled for in ordinary practice.

Jacobi suggests that better results can be obtained if two or more of the animal extracts are given in combination, and he advises the simultaneous administration of the thyroid and suprarenal glands.

#### Bone-Marrow.

Although it has never been regarded as a specific remedy for rachitis, brief reference may here be made to the use of bone-marrow in the treatment of rickets.

Bone-marrow contains a variety of haematogen, and a substance resembling glycerophosphate of lime. Its function appears to be to take a part in the elaboration of the formed elements of the blood. In rickets and osteomalacia, the yellow marrow gives the best results; but in anaemia and neurasthenia the red marrow appears to be the better preparation. Cases of rickets often derive considerable benefit from the use of bone-marrow; and it appears to be of special value in the treatment of the anaemias of this disease. It is possible that some of the improvement that takes place under its use is due to the large amount of fat in its composition, which is readily assimilated by the digestive system.

The fresh marrow of the calf or ox may be given to children in teaspoonful doses, or it may be exhibited as a glycerinated extract, or combined with malt as in the case of the Virol preparation. The writer frequently prescribes bone-marrow in the food, or combined with tonics, as the compound phosphates or lactophosphates;

and he has found it retained and digested in cases which tolerate badly the addition of cream to the diet.

The extracts of the animal glands can only find a small place in the treatment of rickets; they are not indispensable, and it is only in rare instances that they are of real service, or prove more valuable than the drugs that have far longer stood the test of time and experience.

### III. THE TREATMENT OF INTERCURRENT DISEASES AND COMPLICATIONS.

The rachitic child is especially liable to contract intercurrent diseases - more particularly those affecting the gastro-intestinal tract or the nervous system; but, unless the underlying condition producing the disease is recognised, and in all cases the rickety state thoroughly and vigorously treated, it is impossible to hope for any permanent or effectual cure. In catarrhal affections of the gastro-intestinal and respiratory organs, the symptoms may be ameliorated and the disorder treated on general lines; but, at the same time, the child must be put upon an anti-rachitic diet, and suitable drugs administered to cure the rickets and prevent the recurrence of secondary disease or complications.

#### STOMACH AND INTESTINES.

Any catarrh of the stomach or intestines must be corrected by careful attention to the environment of the child, the avoidance of chills to the feet or the abdomen, by regulation of the diet, and by the administration of drugs selected to suit the nature of the complaint. But, as soon as the catarrhal state has been corrected, the vicious influence of the rachitic condition must be broken down, and no case regarded as completely cured, or safe from relapse, until it has been kept on anti-rachitic remedies for some considerable time. After an attack of diarrhoea has been corrected, the irritant cause removed by mild purgatives, and the intestines soothed and disinfected by sedatives and antiseptic remedies, vigorous treatment should be instituted against the underlying cause, if rickets, and the child supplied with a diet containing plenty of fats and proteids. The case will do better without the use of astringents, if in their place there is a free use of cod-liver oil and tonics. All recurrences must be prevented by guarding the child, as far as possible, from sudden chills or overfeeding - special precautions being taken during the time of teething, or in hot summer weather.

In a similar manner, all catarrhs of the lungs may be first corrected, when they occur in children, by the means usually adopted for these conditions. Rickety children are especially liable to bronchitis; and it is expedient to treat all cases on ordinary lines until the conclusion of the acute stage. The bronchitis of a rachitic child is often found to have been caused by some trouble in the nose or pharynx - usually adenoid growths or hypertrophied tonsils blocking the air-passages, and preventing the proper expansion and oxygenation of the lungs. Another common cause is the

fat unhealthy condition of the rickety child. The blood is impeded in its course by the fatty tissues, and capillary circulation is retarded - the result being that congestion readily takes place in the lungs, and pulmonary catarrh is set up by trivial causes which would be thrown off by a healthy child. In the **acute** stage, the patient must be kept in a warm atmosphere, and, if necessary, kept moist by steam/ impregnated with balsams, ~~pure~~ oil, or creosote, until the more dangerous symptoms have subsided.

But, as early as possible, abundance of fresh air must be allowed to circulate about the room; the windows must be kept open night and day, unless special circumstances contraindicate such a course; and the presence of too many sympathetic visitors, vitiating the atmosphere and exciting the child, must be strictly prohibited. The patient must sleep alone in a cot or bed, and must not be overlaid with bedclothes. The constitution must be braced up by an ample supply of generous food and suitable ~~tonics~~ <sup>tonics</sup>. If during convalescence it is possible to remove the child to a warmer climate, this may accelerate the cure and prevent relapses.

The chronic bronchitis of rickets should not be treated by squills, ipecacuanha, and carbonate of ammonia; depressing expectorants and cough mixtures - especially with opiates - are to be avoided, and more reliance placed upon tonics and cod-liver oil. In diseases of the lungs, arsenic (half a minim of Fowler's solution), administered three times a day, is often an excellent tonic during convalescence; and its use is specially indicated if there is any tendency to enlargement of the bronchial or cervical glands. The child must during convalescence be carefully guarded from relapses - particularly during the seasons when cold north or east winds are blowing; but it should not be coddled indoors, but made to live an outdoor life, with abundance of fresh air, and should sleep with open windows.

In the acute stages, the broncho-pneumonia of rickets can be treated by the remedies usually employed in this disease, though creosotal, guaiacol, or other creosote preparations should prove beneficial - more particularly if the respiratory disorder is complicated by diarrhoea or fermentative disturbances of the digestion. In the later stages, the creosote can be combined with hypophosphites and cod-liver oil, and the patient put on a diet containing plenty of fatty material. If this course is adopted, the convalescence will be shortened, and the case more rapidly cured, than if treatment is solely directed towards improvement of the condition of the lungs.

#### NERVOUS SYSTEM.

In rickets the development of the brain is backward, and the reflex nervous system is excitable to a morbid degree, - so that small causes, which would not affect a healthy child, easily set up various spasmodic affections, of which tetany, laryngismus, and convulsions may be cited as examples. There is also defective nutrition of the motor centres; and the condition of this system is comparable to the badly-nourished and hyperexcitable muscles, which are so readily stimulated



and so easily fatigued.

The treatment of all disorders of the nervous system must be of a twofold nature - viz.: (1) to soothe and allay its hyperexcitable condition, removing any reflex cause of irritation, and (2) to feed and build up the starved and ill-nourished nervous tissues. For a prolonged period it may be necessary to administer a combination of remedies that will fulfil both these indications.

#### Sweating of the Head.

The sweating about the head and neck at night causing restlessness suggests some element of defective nerve-control, or some intoxication of the nerves or nerve centres resulting from toxic products circulating in the blood and irritating the sweat glands. In ordinary cases, careful attention to the diet, and the prohibition of food with excess of starch or sugar in the evening meal, together with fresh air, light bed-clothes and tepid sponging at bedtime, may in time prove sufficient to cure this disorder. Some authorities recommend a small dose of atropine at bedtime, and in bad cases this may prove necessary and beneficial.

Holt gives  $1/800$  gr. of atropine, three times a day, for a child of six months; and Vincent also recommends a dose of  $1/600$  to  $1/400$  gr. of this drug, or 3 to 5 minims of the tincture of belladonna, when the child is put to bed - increasing the dose when specially indicated. The last-named writer finds that alcohol produces restful sleep and allays sweating. A small quantity of champagne, with 3 or 4 minims of spirits of chloroform, given in the evening, is remarkably effective in his experience.

It is but seldom that necessity arises for the treatment of sweating of the head by means of drugs; the writer has never had occasion to make use of them, and would discourage the use of such powerful agents as atropine and alcohol in a rickety child, - especially at bedtime, - unless the symptoms were unduly severe, or they resisted proper diet and hygiene. In these circumstances, it would seem preferable to give suprarenal-extract, or even phosphorus, a prolonged trial.

#### Night-Terrors and Insomnia.

The night-terrors and general restlessness, during which the child invariably kicks off the bed-clothes when asleep and lies uncovered, require treatment on general lines. The child should be put early to bed, and allowed to go quietly to sleep in a half-darkened and well-ventilated room, and the bedclothes should be light and not too numerous.

Any irritant causing disturbance of the digestive tract must be removed; and, if necessary, small doses of an alkaline mixture, grey powder, or cascara, may be given to check the restlessness due to indigestion or fermentation.

As the child grows older, it must not be permitted to have late suppers; and starches and sugars should be avoided at night - a small meal of milk, with a little biscuit or some malted food, should prove sufficient to allay hunger at this time. There should be no games or romps just before bedtime, so as to keep the child

quiet and free from excitement.

For a short time, it may be necessary to give nightly a small dose of bromide to insure a better habit, and thus encourage the child to go to sleep at a regular hour.

#### Tetany.

The disturbed and excitable condition of the nervous system in rickets is well illustrated by the frequent attacks of tetany or motor spasms which are of frequent occurrence in these children, and which are only seen in adults if nutrition is lowered by prolonged lactation, prolonged attacks of diarrhoea, or exhausting diseases.

When a child is suffering from an attack of tetany, the source of reflex irritation must be searched for and removed, sedatives administered to soothe the nervous hyperexcitability, and, as soon as possible, vigorous antirachitic remedies adopted in order to complete the cure. If the presence of worms be suspected, a vermifuge should be given; but more often the attack has been induced by the presence of coarse and fermenting food in the stomach, or by excessive drain of the tissues from prolonged diarrhoea. Tetany is frequently associated with gastric dilatation - especially when it occurs as a complication of rachitic disease.

It is therefore of the utmost importance to clear out and disinfect the alimentary canal, and at the same time provide a diet which is bland and anti-fermentative. It is necessary to remove all coarse irritating foods - e. g., oatmeal, jams or fruits with skins, or vegetables with coarse stalks and fibres. At the same time, starvation after the first few days must be avoided, and plenty of nourishing food given to keep up general nutrition, which is exhausted by disease, and the nerve tone lowered, - so that the child will require roborant measures of treatment. It is advisable to cut off all milk and farinaceous foods, and to put the patient upon plenty of meat, - pulped or scraped, pounded chicken, and various meat soups, - with the aim of introducing, as far as possible, a full proteid diet.

Stoeltzner (Jahr. f. Kinderh., June 11, 1906) has found that the addition of calcium chloride or acetate to the foods of infants produced an increased irritability of the nerves, as well as a recrudescence of tetanic spasms. The sodium chloride and magnesium carbonate - the other inorganic constituents of milk - do not produce this effect. Our author therefore concludes that the frequency of tetany in artificially-fed infants is due to the use of cow's milk, in which the amount of calcium present is five times as great as in human milk. He further suggests that the frequent occurrence of tetany in rickets can be explained by the increased amount of calcium circulating in the blood, which is not used up in the formation of bone.

The alimentary canal must be cleared of fermenting food, or protracted diarrhoea checked by an initial dose of castor-oil or calomel, followed by a course of gastric sedatives, and intestinal antidiarrhetic remedies, - such as bismuth and chalk, or salol, with small doses of opium, - if the diarrhoea is profuse, or if there should be severe pain.

During the attacks of tetanic spasm, chloral and bromide, - preferably in combination, - or small doses of antipyrin, must be given several times a day, and for some length of time, in order to soothe the nervous system and prevent further spasms or convulsions. At six months of age,  $\frac{3}{4}$  - 1 gr. of chloral and 4 grs. of ammonium bromide may be given by the mouth, or double that amount may be injected into the rectum. If the child becomes too sleepy to take food, the limit of safety has been passed, and the dose of the sedative reduced or altogether discontinued. The acute pain of the spasms may be partly relieved by hot baths, or by friction of the extremities.

In the later stages, a stimulating antirachitic treatment should be instituted; the diet should be rich in proteids and fats, cod-liver oil, phosphorus, iron, and strychnine may all prove useful remedies, and their benefit increased, if ~~massage~~ and daily douches are given at the same time, and mild electricity also in stubborn cases.

It is absolutely ~~essential~~ if, in cases of tetany permanent cure is to be obtained, to treat the underlying condition of rickets. If all other treatment fails, the thyroid-extract may be given a trial: it has, however, not proved a great success in ordinary cases of tetany due to rickets; and it is possible that good results are only likely to be obtained when there is some abnormal condition of the parathyroid gland.

If we accept the conclusions of Stoeltzner (Jahr. f. Kinderh., Sept. 4, 1906), the administration of the thyroid-extract in the tetanic attacks of rickets should prove useless. He opposes the view that functional disturbance of the parathyroids gives rise to the tetany of rickets - basing his conclusions on the dissimilarity of the symptoms, and the different effect of diet on the two diseases.

In tetany there are no fibrillary twitchings, tremor, tachycardia, albuminuria, or inclination to sleep, - whereas all these symptoms are present in animals after the removal of the parathyroid glands. The influence - or rather the opposite effect - of diet in the two conditions is even more striking: for the tetany of rickets is aggravated by a milk diet, but the use of milk as a food for animals, after the removal of the parathyroids, lessens the frequency and the severity of the spasmodic attacks. Therefore, it seems hardly probable that much good can result from the administration of thyroid-extract in the tetany of children suffering from rickets.

The writer has lately observed a case of tetany in an adult, a lady recovering from an exhausting illness. There were frequent attacks, and she herself remarked that the condition was always aggravated by a milk diet; but, when she was kept on a meat ~~ddet~~, - chiefly underdone pulped steak or cutlets, with only well-baked biscuits (Lehmann's), - the attacks did not recur so often, and she made steady progress towards recovery. There was considerable indigestion and flatulence, but no gastric dilatation.

#### Laryngismus Stridulus.

The treatment of laryngismus is based upon lines very similar to those laid down for an attack of tetany.



The parents should be warned that a rickety child is hypersensitive to any reflex stimulus, and that the smallest excitement, or even a breath of cold air, is sufficient to induce laryngeal spasm. These children, for fear of such attacks, are far too frequently kept in overheated and ill-ventilated rooms, and unduly coddled or overclothed; they must be encouraged, with due precautions, to keep in the open air as much as possible, and to live regular lives, avoiding excess of food and over-excitement. Attacks of laryngismus are more liable to come on in hot stuffy rooms than in fresh cool airy apartments.

The digestive system must be kept in order; constipation may require special attention, and treatment for this condition often produces reflex irritation that sets up an attack.

The treatment of laryngismus stridulus resolves itself into methods adopted:

- (a) To check the spasm.
- (b) To remove the source of irritation.
- (c) To soothe the abnormal excitability of the motor centre, and dull it until the source of irritation is removed and the stability of the nervous system re-established.
- (d) To treat the underlying rachitic state.

(a) Methods Adopted to Check the Spasm.

The acute attack may be stopped by dashing cold water in the child's face or on the hands, by smartly slapping its cheeks, or by passing the finger rapidly to the back of the pharynx in order to induce vomiting. Severe cases may require the inhalation of chloroform to relax the spasm, or hot fomentations may be applied to the throat, and, if the attack is prolonged, the child may have to be put into a hot bath.

(b) & (c) The Removal of the Source of Irritation, and the Soothing of Abnormal Excitability.

The reflex cause of irritation must be sought for and removed. Any gastric disturbance must be corrected, and a dose of castor-oil or an enema will in most cases probably meet immediate indications, and sweep out fermenting products; afterwards, attention to the diet, and simple digestive tonics or bismuth and soda mixtures, will soothe gastric or intestinal irritability.

Enlarged tonsils, adenoids, or elongated uvula - a frequent cause of reflex irritation - should be removed, and bronchial or laryngeal catarrh may require appropriate remedies. If teething be the cause, it may even be necessary to lance the gums.

All emotional excitement must be avoided, fits of temper, laughter or tears, and late hours or frequent visitors to the nursery - especially at bedtime - must be discouraged, - so that the child goes quietly to sleep: for these attacks often come on at night, or in the early hours of the morning. The child must be put upon a course of bromide and chloral for some time, as recommended under tetany, and should be kept under the influence of these drugs, until the nervous system has regained a measure of stability. An early discontinuance of the sedative remedies had been known to lead to

relapses, or even sudden death; and the mixture of chloral and bromide may have to be given for many weeks. Some cases appear to do better with valerianate of zinc, or even small doses of codeia.

Holt's experience with antipyrin leads him to believe that this drug is more effective than the bromide or chloral. He gives two grains every four hours to an infant a year old, diminishing the dose as soon as there is improvement of the symptoms.

(d) Treatment of the Underlying Rachitic Dyscrasia.

While the child is under sedative treatment, antirachitic measures must also be adopted.

The diet should contain plenty of animal fat~~d~~ or cream and raw meat-juice; the general hygiene must be improved, and plenty of fresh air insisted upon - the child being kept out of doors, unless the weather is very inclement.

Cod-liver oil should be administered, and in this disorder, phosphorus or arsenic may prove especially valuable; but it is necessary to regard these drugs as nutritive tonics, and to give them for some considerable length of time before they can be expected to cause any marked improvement in the rickety condition.

General Convulsions. - Attacks of tetany or laryngismus may culminate in general convulsions. In all infants over six months of age - particularly if fed by artificial means - rickets should be always suspected as the possible cause of convulsions, and the child carefully examined for any evidence of the disease.

The convulsions may be treated with sedatives, and the inhalation of chloroform or amyl nitrite may be useful in checking the violence of the seizure, and help to ward off cerebral haemorrhage. As soon as the acute stage is over, the irritant removed, and the nervous system soothed by sedative remedies, the great underlying cause of the condition - the rachitic disease - must be treated, and the child's system toned up to prevent the recurrence of further attacks.

Any failure to recognise the presence of rickets will inevitably result in further convulsive attacks, with the danger of permanent mental disablement, or true epilepsy appearing in later life.

In conclusion, the writer would insist that rickets must be regarded as a slow chronic disease, liable to relapses and complications, requiring long and careful supervision, and a careful study of individual patients. The general routine principles of adding fat to the diet, and of vigorous drugging with cod-liver oil and tonics, - valuable remedies in their proper place, - should be avoided, and the treatment of rickets be as carefully considered as any other case of prolonged illness necessitating the guidance of the medical man.

No one would treat a case of enteric fever in a slap-dash fashion, yet rickets, because familiarity has bred contempt, is far too often dismissed in a perfunctory manner from the consulting room, though the disease may cause lifelong injury to the system, or its complications result in the early death of the child.

For a considerable time, on account of the disordered digestion, and the production of fermentative and

toxic products in the stomach and intestinal tract, children with rickets require a rigid diet - often containing very small quantities of fat. The entire alimentary canal must be cleansed, the liver relieved of all extra work; and, until this is accomplished, only food must be given that can be easily assimilated, and which does not throw much work on the digestive organs. In the earliest stages, cases often do best on a low fat diet, and therefore broths, whey, and buttermilk may give the best results; and, as the digestion improves, slow increase can be made with the fats and proteids, until the point of toleration is reached, and the best diet is found for each individual patient. We should endeavour first to find the optimum diet, before striving after an ideal maximum which cannot be tolerated in all cases.

In the same manner, the use of strong tonics (iron, arsenic, and phosphorus) must be held in reserve until the case has been under treatment for some time; and it is advisable, in the first instance, to tone up the digestion, and improve the functions of the stomach and intestines with alkaline mixtures aided by bitter tonics. The intestinal tract must be regulated, the excessive secretion of slime and mucus, and the tendency to constipation or diarrhoea corrected, and a thorough disinfection of all toxic products carried out, before burdening the digestive functions with an excess of fat, which is totally unable to assimilate or pass into the system, and thus benefit the malnutrition present. If these measures are carried out effectively, in the later stages tonic remedies and richer diets will be better borne, - so that the case will proceed more rapidly to a complete cure; and there will be little danger of relapses from gastric disorders, which are only too often set up by the hasty and ill-advised overfeeding and drugging in these cases of rickets.

The brilliant results obtained in rickets with the use of so theoretically unsuitable a food as buttermilk, or Babeurre, suggest that many cases of rickets in the early stages make better progress on a low fat, but easily assimilated, diet, together with thorough disinfection of the intestinal tract. Buttermilk, by reason of its composition and the presence of lactic acid, fulfils both these conditions; and it seems safe to assume that many cases would do better, for a certain time at least, on this food than on a diet loaded in haphazard fashion with extra fat, in the form of high-percentage cream and cod-liver oil, which can only cause gastric disorder, vomiting, offensive stools, and an overproduction of butyric acid. If rickets is due to absorption of toxins from the intestinal tract, this fermentation can only result in further harm; and, before fat is introduced into the food, it is of cardinal importance to insist on the thorough disinfection of the alimentary canal and a prevention of its recurrence.

A great field lies open to the general practitioner, as he will be able to do more good, and cope more efficiently with the widespread ravages of rickets, by constant attention to the diet and hygiene of infants.



entrusted to his care; and he will obtain better results in his efforts towards the prevention and cure of this disease than can be ever obtained from an irregular attendance and treatment of a case by a specialist, or by paying occasional visits to a hospital. Cases of rickets require constant care and vigilance, as well as a thorough attention to all the small details of diet, hygienic clothing, and exercise. It is necessary to "know the child" in its daily life, to visit its home, and gain a thorough knowledge of the methods of the mother in its upbringing, with regard to its food, hygienic arrangements, baths, clothing, exercise, and usual environment, - so as to be placed in a position to correct any error or faulty habit amongst all the details that go to make for vigorous growth and development in early life. If we wish to cure rickets, we must educate the mother and study each individual child in its own home, and under the conditions of life

that circumstances decree its daily lot is cast for good or ill.

### TREATMENT OF DEFORMITIES.

The treatment of the deformities of rickets scarcely comes within the scope of this thesis, but a few general considerations on this branch of the subject may here not be altogether out of place.

Though the actual correction of deformities may need the aid of a surgeon, much may be done before a case passes out of the hands of the general practitioner; and, in a certain proportion, so much improvement may result from rest, baths, massage, and other methods of treatment, that recourse to operative interference may be postponed or rendered quite unnecessary.

During the time that the bones are soft, they may be straightened by gradual pressure or by force; but when once they have passed into the stage of eburnation, their superlative hardness will resist any measures that are supplied - short of correction by osteotomy, or some other form of surgical operation. The deformities of rickets have a tendency to natural cure, and therefore undue haste to correct curvatures is never advisable, and is quite uncalled for in the majority of cases.

#### THE HEAD.

The bosses of the frontal and parietal bones may slowly disappear, but often persist throughout life in a modified form; and it is, of course, impossible to remedy these structural defects by surgical treatment.

#### THE SPINE.

The curvature of the spine is not a disease of bone, but of impoverished muscles and ligaments; but, if left untreated, may lead to permanent deformity of the bones of the vertebral column.

Babies should not be allowed to sit up too soon, before the spine and the muscles of the back are able to support the weight of the body. The practice of

nursing infants always on the same arm is very reprehensible, and should always be discouraged, as this habit often leads to the production of spinal curvatures. If the child is a weakling or the subject of rickets, it should be carried on a pillow, and kept flat on its back; but, unless the weather is very inclement, it ought to be in the open air for the greater part of the day, and not kept indoors or in overheated apartments. At the same time, measures must be taken to tone up and strengthen the weak and flabby parts by the application of massage to all the spinal ligaments and muscles. It should be given at least twice a day, and, if necessary, olive- or cod-liver oil may be used as a lubricant. Considerable improvement may follow the use of douches to the muscles of the back, and the same may be used in conjunction with massage. If the child is under eighteen months of age, hot water should always be employed, but over this age cold water should be preferred, as it has a greater tonic effect; and the addition of salt to the douche is often very stimulating and beneficial.

In the majority of cases, it is advisable to avoid the use of splints; but, if the deformity of the spine be very great or persistent, the guttapercha splint, recommended by Noble Smith (*Curvatures of the Spine*, p. 29), may be given a trial. This splint is lined, and attached to the shoulders by armholes, and below to the abdomen by a bandage. It thus forms a good support to the protruding abdomen, and helps to keep it in a more normal position.

In the case of older children, the rocking-chair, recommended by Professor Epstein of Vienna, may be found of some service. The child sits with its face towards the back of the chair, and its feet rest upon the hinder part of the rockers, - so that the weight of the body is taken off the extremities, and, as the trunk leans against the chairback, the spine receives a certain amount of support.

It is only necessary to add that these cases should never be supported by jackets of plaster of Paris.

#### THE PELVIS.

In girls with rickets, careful watch should be kept on the pelvis; and, if the case is seen at an early stage, deformity or flattening of these bones may be prevented by the exercise of special precautions.

If all the bones are soft, it may be necessary to keep the patient in the recumbent posture, lest the pressure of the trunk from above, and from the legs below, forces the sacrum forwards and the ischia inwards, and thus produce the characteristic distortion. But continual lying on the back may in itself lead to a flattened pelvis, and cause the symphysis pubis to sink backwards. On this account, a certain amount of walking or free movement may be advisable; and, if kept recumbent, the position of the child should be frequently changed to prevent permanent curvature or distortion in one direction.

### THE RIBS.

The depression of the ribs by atmospheric encroaches upon the space in the thorax allotted to the lungs, and helps to keep up a condition of chronic bronchitis. Unless the lungs freely expand, the deformity of pigeon-breast will remain to some extent throughout adult life.

The muscles of the thorax - and especially the intercostals - must be stimulated to encourage free expansion; and this is best carried out by briskly rubbing the chest wall, twice a day, with a liniment containing turpentine or camphor. The child must be made to shout or even cry; and, if old enough, trumpet-blowing or the making of soap-bubbles, may help towards better and deeper inflation of the lungs.

A firm flannel bandage round the abdomen is also of considerable assistance: for it gives support to the lax abdominal walls, prevents the breathing from being carried on entirely by the diaphragm, and forces the child to bring the intercostal muscles into play. The binder must not be worn continuously, but must be put on for an hour twice a day, and slackened if it causes any discomfort or distress.

### THE EXTREMITIES.

If a case of rickets is seen in the early stages, the deformities of the extremities must be prevented by keeping the child off its feet; and constant endeavours should be made to tone up the lax muscles and ligaments by the use of daily baths, douches, friction, and massage.

The child ought never to be allowed to walk: for, if this precaution is taken, better and more rapid results will be obtained than from the employment of splints, which is a slow method of treatment, frequently carelessly attended to by the mother, and extremely irksome to the child.

In order to ward off the deformities of the upper extremities, the child must be kept from crawling about on the floor: for, while doing this, it throws the whole weight of the trunk upon its hands and arms, and the soft decalcified bones, unable to support it, bend beneath the pressure from above.

The rocking-chair of Professor Epstein supplies a welcome change of posture, if the child is restless and cannot be kept constantly lying on its back. The fat and ~~pneumous~~ rachitic infant requires special attention: for, in these cases, the super-structure is too heavy for the supports, and the extremities, with flabby muscles and ligaments, yield beneath the load, and thus produce curvatures and distortions of the bones. A rickety child should never be encouraged to walk by artificial aids - such as railings, chairs, or patent contrivances: for, as soon as the muscular system is strong enough, it will want to walk of its own accord, and by that time the legs will be in a fit condition to support the weight of the body.

If splints are really needed, they should be applied while the bones are soft, and before the stage of eburnation. Children with rickets have an apparent fondness for sleeping in extraordinary attitudes, often



with the legs crossed or curled upon the abdomen, and may thus produce certain deformities. In these cases, it is better to apply splints at night; and the simple wooden splint, carefully padded, stretching from the thigh to a few inches beyond the feet, answers admirably all indications, and is far less cumbersome than one made of iron. If it should be considered advisable, the splints can also be worn during the day for several hours. The capiper splint, fitting into the boot, cannot be recommended: for, unless the child is under frequent observation, the bones may after a time begin to bend in the opposite direction to the deformity for the correction of which the splints were applied, and thus the remedy prove worse than the disease.

Flat-foot may be treated by not allowing too much of the weight of the body to fall on the feet, and by suitable alterations to the boots - usually elongating and crooking the heels so as to bring the body weight to bear outside of the tarsus. A small leather stud is sometimes fixed on the inner side of the sole of the boot for the same purpose. ~~It is~~ seldom necessary to put an artificial arch or spring into the sole of the boot. Special reliance must be placed upon frequent douching and massage of the foot.

Knock-knee requires the application of a pad between the two knees, and firmly strapping the legs to cause inward pressure, or by the use of special splints applied to the outer side of the thigh and leg - the same to be worn for some months. Intractable case, of course, require osteotomy.

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Surgical interference should not be resorted to under three years of age; and it may even be deferred to a later date, as rickety deformities often recover to a considerable degree without any treatment. As a rule, of the deformities are well-marked, and the child is under three years of age, splints should be applied, and, if necessary, there should first be forcible straightening of the limbs. If the deformity remains stationary for three months, and is not benefited by padded splints, which are carefully adjusted from time to time, it is advisable to perform an osteotomy.

In a large measure, everything depends upon the position in life of the patient. If the deformity is seen early, and the parents are in good circumstances, - so that the patient can be frequently visited, the splints readjusted, and general treatment with douches and massage carried out in a systematic fashion, - the necessity for operation is comparatively rare. But, amongst the poor, - who cannot afford the frequent visits of a doctor, and who fail to carry out directions in a thorough or intelligent manner, - it is often better to resort to surgery, and forcibly straighten the limbs, or perform an osteotomy.

If fractures occur, the periosteum usually remains intact, and the ends of the bones are not separated, - so that the limb can be straightened with ease, and the broken parts kept in apposition by means of appropriate splints. Green-stick fractures are quite

common about the extremities and clavicles.

The child should always receive thorough and prolonged antirachitic treatment; and the administration of small **doses** of phosphorus may help to promote the growth of new and stronger bone.

CONVULSIONS.

J. B., aged 1½ years, was brought for advice on account of the occurrence of convulsions, which the mother declared were due to teething. The child was a very rickety specimen of humanity, and undoubtedly had a series of convulsions whenever it cut a tooth.

In considering the treatment of this case, the question arose whether it would be possible to anticipate natural events by lancing the gums, and thus avoid attacks of convulsions. On the appearance of another tooth, this was done, and the child escaped the expected convulsive seizure.

It is possible that, in the case of this rickety child, the irritation of an appearing tooth pressing upon the gum acted reflexly upon the unstable nervous system, and thus produced a nerve-storm or explosion, culminating in a convulsion. This irritation would not affect a normal child, but was quite sufficient to disturb the equilibrium of the hypersensitive and unstable nervous system induced by rickets in this patient.

PARALYSIS.

T. B., aged 2 years, was presented for treatment on account of "paralysis". The boy had never attempted to walk, and could not stand without assistance. He was a typical rickety child, but there were no signs of paralysis and no wasting of the muscles. At the time he came for medical treatment, he was being carefully fed, although he had been given a free allowance of bread "sop" from 2 to 10 months of age.

He was put on malt and cod-liver oil (equal parts), one drachm, thrice daily, for a month - the dose being increased to two drachms for the next month, and to three drachms for the third month, together with an appropriate dietary. The mixture was readily taken and tolerated.

At the age of 2 years and 4 months, he began to stand, and he was able to walk four months later.

Possibly the delay in walking spared the child having bony deformities: for now, at the age of three and a half years, his limbs are perfectly straight.

ADENOIDS.

Adenoids are a frequent concomitant of rickets, and the necessity for their thorough removal is well illustrated by the following case:

A rickety boy, aged 10 years, who had always been subject to bronchitis and who during the past 6 months had had attacks of air-hunger with very marked dyspnoea, was brought to see if anything could be done to stop the attacks.

The nasopharynx was found to be full of adenoids, so they were completely removed under chloroform.

Nine months have now elapsed since the operation, but the child has not had any attacks of asthma, and



only one mild attack of bronchitis, instead of being laid up with an illness every month.

The damage of a permanent character which may be done to the lungs, by repeated attacks of bronchitis, suggests that it is highly important that we should strive to protect the child against them by endeavouring to ascertain the exciting cause, and, if possible, remove it at the earliest convenient opportunity.

Adenoids and enlarged tonsils should always be looked for in a rickety child: for there is grave danger to future health if they are left untreated. Children suffering from rickets do particularly badly when they contract infectious diseases; but, if they have adenoids and enlarged tonsils, they appear to be specially susceptible to the poison of diphtheria during an epidemic of the same, and are often attacked primarily by the nasal form of the disease. They are also more prone than other children to pulmonary complications in this disease, by the direct spread of the membrane down the trachea and bronchi. In addition, they are also liable to deafness, often associated with Eustachian obstruction, due to the presence of adenoids, around the orifice of the Eustachian tube - the removal of which restores the hearing to normal in due course.

The neglected and unhealthy condition of the nasopharynx may also lead to otitis media in the case of a rickety child, - so that due attention to the condition of the throat and nasopharynx, though it may seem a small matter, is of the utmost importance in the thorough treatment of this disease.

#### ABDOMINAL ATONY.

A mother brought her son, aged 4 years, for medical advice on his illness which was that of a very troublesome dyspnoea.

He had frequent attacks of bronchitis, and, on account of the atony of the abdominal muscles, a medical practitioner had advised the use of a belt, which same had been worn for twelve months.

The bases of both lungs were collapsed: the cause appeared to be the bandaging of the abdomen and the restriction of the movements of the chest.

The case derived great benefit from massage of the abdominal muscles, and free exercise, - walking, flexion of the body, and then making the child assume the erect position; and the patient was also given balloons to blow up, in order to help the expansion of the chest.

About the same time (March, 1907), a case of well-marked abdominal atony, in a child of three years, presented itself for advice; in it there was complete diastasis of the recti muscles.

The abdomen was distended, the normal abdominal lines lost, and the bowels obstinately confined. The anterior fontanelle was open, Harrison's groove well marked, and considerable bowing of the tibiae.

This case derived much benefit also from massage and free exercises.

Both these patients were put on an antirachitic

diet, with raw meat-juice; and they had ~~th~~ twice daily, gr. 1/60 of phosphorus in cod-liver oil.

### DIASTASIS OF THE ABDOMINAL MUSCLES.

A female child, aged  $2\frac{1}{2}$  years, has been artificially fed with patent foods all her life. She shows marked general signs of rickets, and has only just begun to walk.

The abdominal recti muscles are separated in their entire extent from the ensiform cartilage to the pubis. When the child is lying quietly on her back, the finger tip can be run up and down in the sulcus between the adjacent edges of the muscles.

Whenever the patient cries, or attempts to sit up, a median ventral hernia appears between the muscles, causing a separation of fully  $2\frac{1}{2}$  inches at the level of the umbilicus. The hernia is visible from the ensiform cartilage to the pubis.

### EXOSTOSES.

(The following cases have been seen at the Liverpool Children's Infirmary, where they are under the care of Mr. R. Craig Dun.)

#### (A) Multiple Exostoses

##### Associated with Rickets.

Boy, aged 6 years, has a typical rickety-shaped head, and slight genu valgum, which has been much worse but improved under antirachitic treatment.

He is said, when younger, to have had "large joints" and pot-belly. When 4 years old, the swelling inside the left knee was first noticed: subsequently others appeared, and the boy has now no less than eleven exostoses.

##### Distribution.

- 1.- 2nd right metacarpal) size of pea.
- 1.- 4th right metacarpal)
- 1.- External aspect upper  $\frac{1}{3}$ ) hazel nut.  
of right humerus
- 1.- 3rd left metacarpal ) pea.
- 1.- Dorsal aspect left unciform)
- 2.- Antero-internal aspect of )  $\frac{1}{2}$  a walnut.  
left femur in lower third)
- 1.- Right tibia, half an inch ) hazel nut.  
above internal malleolus)
- 1.- Internal aspect supracondylar) hazel nut.  
ridge of left femur)
- 1.- Internal aspect of left tibia )  
 $1\frac{3}{4}$  inches below upper artic-) walnut.  
ular surface)
- 1.- Anterior aspect of left tibia )  
2 inches above the tip of the) walnut.  
internal malleolus)

Several of the larger ones were removed, and were found on examination to be typical cancellous osteomata.

#### (B) Exostoses in a Rickety Child.

Boy, aged  $4\frac{1}{2}$  years, stunted in growth, and presenting slight curvature of the tibiae.

He had two exostoses distributed as follows: one on the inner aspect of the lower third of the right femur, one inch above the adductor tubercle; and one two inches above the left internal malleolus.

Exostoses are not of common occurrence in association with rickets; and Craig Dun affirms that he has only seen these two cases, in which a definite history of rickets could be obtained.

Chance (*Bodily Deformities*, p. 223) refers to the tendency to abnormal deposition of earthy salts, which same does not always cease when the weakened bone is resupplied with earthy matter, - so that exostoses and bony spiculae are often thrown out, and cause great inconvenience. Furthermore, he mentions in this connection a specimen in the museum of the Royal College of Surgeons of England, in which the bones of the extremities are united to the trunk by long spicules passing across from part to part, thus rendering movements an impossibility. During life the man was employed in a sentry-box to watch other men and keep them at their work.

Exostoses must be distinguished from the bony ridge on the inner aspect of the upper part of the tibia, where the internal ligament is attached, which occurs quite commonly with genu valgum.

#### MASKED RICKETS.

Rickets may run a fairly mild course, or be overlooked when catarrhal or other symptoms are the prominent feature of the disease.

A boy, aged 3 years, was always healthy till six weeks ago, when he had an attack of measles, which ran an ordinary course.

As soon as the child was allowed to run about, his legs began to bend, and he showed typical rachitic deformities of the tibiae.

Previous to the attack of the measles, the tibiae were perfectly straight. The past history did not afford much information of the rachitis in infancy, though the child had catarrhal ailments ascribed to dentition. All the teeth were present undecayed, and the anterior fontanelle was closed.

The legs were forcibly straightened, and the child put on an antirachitic diet. Raw beef-sandwiches were well taken, easily digested, and proved very beneficial. The boy made a rapid recovery, and the limbs are now straight, and there has been no return of the curvatures.

#### SYPHILIS.

Syphilis may predispose to rickets, and this by producing disturbances of nutrition.

G. M., aged 14 months, the offspring of syphilitic parents, was born with a secondary eruption; this was cleared up under treatment with grey powder, guarded with small doses of the compound ipecacuanha powder.

Some months later, it had troublesome vomiting, and the treatment with mercury was resumed; in a short time the vomiting ceased.

The patient is now showing signs of rickets: no attempt at walking, marked curvatures of both tibiae, typical Harrison's groove of the thorax, and it is very subject to attacks of bronchitis. The child is



improving under cod-liver oil and other antirachitic medicaments.

### ACHONDROPLASIA.

Achondroplasia undergoes its full evolution during the first half of pregnancy, whereas it is possible that rickets develops during the later months.

During the latter part of March of this year, a boy was brought for medical advice because he was backward in his growth. He was 7 years of age, but only 36 inches in height.

The arms and legs were very short, the epiphyses enlarged, the roof of the nose depressed, and there was foreshortening of the base of the skull. The boy also had macroglossia.

The case was probably achondroplasia, but the thickened epiphyses almost suggested that it could be classed as one of intra-uterine rickets with arrest of growth.

### BAD RESULTS OF ZEAL IN THE PARENTS, BOTH WITH REGARD TO DIET AND EXERCISE, LEADING FINALLY TO RICKETS IN TWO CHILDREN.

Many parents - especially when faddists - injure themselves and their children by the abuse of methods, which, if wisely employed, would prove beneficial to health and nutrition.

In the household, now being described, both parents are ardent pupils of the Sandow school; the father is a gold medallist, and pictures of himself, in classic attitudes, and in a state of nudity exhibiting large hypertrophied muscles, adorn the walls of his home. He is a big powerful man, but is pale and pasty-looking; he does not enjoy robust health, but zealously performs Sandow exercises every night. His pulse is feeble, and there is some hypertrophy of the heart.

The mother is a small, intensely neurotic woman, with well-developed biceps, but the rest of her muscular system is flabby and ill-nourished. She is also a great exponent of the Sandow methods, and informed the writer, with great pride, that she was placed first in the ladies' class. She attaches inordinate importance to deep breathing, which she practises daily; even when recovering from an attack of broncho-pneumonia, her respirations were often as low as 9 per minute.

Three children have been born in four years, and one is dead. The confinements have left the mother's abdominal muscles in a wretched toneless condition; and her skin lies in loose folds, and lacks elasticity. She is very anaemic, and has a soft mitral bruit, left after rheumatic fever; constipation, which is a great trouble, is partly due to muscular atony, but also her ~~family~~ habits, as she never takes regular meals or proper food. Her appetite is poor and capricious. Before marriage, she was a hospital nurse, but, though quite intelligent, she had brought up her children in a most unsatisfactory and unhygienic fashion, largely through excess of zeal and over-anxiety.

Both children show marked evidence of rickets. The eldest is aged  $2\frac{1}{4}$  years. He began teething between three and four months of age, and at the present time he has seventeen teeth, most of which are decayed. For the first fortnight of his life he was breast-fed, and then brought up on Robinson's Barley and other patent foods.

He has a very well-marked rickety head, deformed chest, rickety rosary, thickened epiphyses, bowed legs, and is subject to frequent attacks of bronchial and gastric catarrh. Until lately, he always perspired freely about the head at night, and is still a restless sleeper. When seven months old, he was operated upon for enlargement of the cervical glands.

The mother says that from an early age the legs were inclined to bow. Under advice, he had caliper splints fitted to his boots, and wore them regularly for six months; but, when he was first seen by the writer, they seemed unnecessary, - so that he advised their discontinuance, and ordered massage of the calf muscles to be given night and morning. The splints were tending to produce the opposite deformity to what they were apparently designed to correct. At a later date he was seen by a specialist, who agreed that the child was better without splints; and, apart from not allowing too much body weight to fall on the feet and elongating and crooking the heels of the boots, no treatment at all was considered necessary beyond that of a general antirachitic nature.

The baby, aged 12 months, a fat heavy pasty-looking child with patches of eczema on the head and face, showed marked signs of rickets: a large head with prominent bosses, widely patent fontanelle, thickened epiphyses, rickety rosary, protuberant abdomen, foul motions, and a great tendency to catch cold and have mild attacks of bronchitis.

The child was first seen at eight months of age; and, as it seemed to be in an unsatisfactory condition, inquiry was made into its diet, mode of living, and general hygiene. At first the answers seemed unsatisfactory; but, though the milk mixture was of appropriate strength, the writer afterwards discovered that the child was being fed on abnormally large quantities, and even roused up during the night, every three hours, to be fed, - so that it was really getting an excess of food. In addition to milk, because of the rickety condition, the child was liberally dosed with large quantities of strong beef-tea and cod-liver oil.

The inevitable consequences were bad nights, irritable temper, eczema of the face with flushing thereof, distended abdomen, foul oily stools, and stinking urine. After alteration of the diet, the child improved for a time; but the mother, in her anxiety to bring the infant on rapidly, persisted in overfeeding it.

The patient was again seen at the age of 13 months; it had then 7 teeth, and weighed 22 lbs. It has a widely-patent fontanelle, was excessively fat, florid in complexion, and had eczema of the face. The mother, who was recovering from pneumonia, complained that the baby

cried a great deal, and always suffered from hiccough and indigestion. The child looks gross, flabby, and unhealthy, and never seems to smell sweet. It is a very restless sleeper, and always kicks off the bedclothes.

During the day its meals are frequent, often commencing between 6 and 7 in the morning, and continuing at intervals till bedtime. The standard meal is about seven ounces of food consisting of milk diluted with less than one-third of barley-water; and, to each bottle throughout the day, is added two teaspoonfuls of thick bought cream. At mid-day it has strong beef-tea, as well as stewed apples or fresh bananas. The child is even woke up at intervals during the night to be fed. A specialist recommended cod-liver oil for both the children, - so the mother, in addition to the excess of cream in the diet, dosed the infant with two teaspoonfuls of this drug twice daily.

The result of all this has been complete disorder of the child's digestion. The breath is offensive; the abdomen swollen; the stools frequent, oily, and foul-smelling; and the urine so highly coloured as to stain the napkins deeply, being also most offensive in odour.

The general hygienic condition are not satisfactory; the children live in one room, day and night, which may be properly ventilated, but always smells of decomposing urine - a condition, according to Kassowitz, suitable for the development of rickets.

The treatment adopted was the cutting off of all cream and fatty foods; and for the first few days the child was fed on thin mutton-broth and barley-water, and afterwards on milk and water (equal parts), thin porridge, and broths. An attempt was made to feed the child with buttermilk, but it was only possible to obtain an intermittent supply, and the result was therefore unsatisfactory.

Under treatment, the diarrhoea ceased, the child became contented, slept at night, and gradually showed signs of general improvement. It was kept out in the open air, and the nursery was thoroughly ventilated. Unfortunately, the mother persisted in her bad habit of overfeeding the child, even when strict rules were laid down about the diet.

These two children were typical rachitics, and illustrate the danger of applying a little theoretical knowledge into bad practice. The family history is interesting, showing that excess of physical development in the parents is no help towards the production of healthy children.

#### BRONCHITIS.

A child, aged 18 months, was brought for treatment of repeated bronchitic attacks. He has been largely fed with sopped bread, and is unable to stand.

There is much sweating of the head, especially at night; the anterior fontanelle is widely patent; Harrison's groove is well-marked; and there is depression of the lateral aspects of the chest wall. The tibiae are typically curved, and there is also genu



valgum.

The father is an alcoholic, and the mother has a typical rickety pelvis. Four children have been born: two were still-born, one died of convulsions at three months of age, and the fourth - referred to in these notes - has marked rachitis.

The child was ordered antirachitic diet, together with phosphorus and cod-liver oil. The curvatures of the tibiae were straightened by keeping the legs in splints. Under this treatment rapid improvement was observed.

#### CONVULSIONS.

The following case is instructive, owing to the family history surrounding it.

A child, aged 2 years, was attended for convulsions. The father and mother were healthy, and there were four children. The first two were breast-fed, and are quite healthy. Then the mother gave herself up to the pleasures of society, becoming a leader of fashion; and the last two children, left to the tender mercies of a nurse, were fed on milk and barley-water, and biscuits and bread and milk, up to the age of nine months.

Both these children are rachitic: the elder, aged 4 years, has dental decay, pigeon-chest, curved femora and tibiae. The younger, aged 2 years, - the present patient, - has enlarged epiphyses, widely-open fontanelle, delayed eruption of teeth, pot-belly, curved tibiae, and suffers from chronic constipation.

After the immediate treatment of the convulsion, the digestive disorder of the child was corrected by a course of grey powder; and it then rapidly improved under cod-liver oil and malt, and there has been no recurrence of convulsions.

The brain-storms, which so frequently are observed in rickets, - convulsions, tetany, and laryngismus, - must have some close relationship: for, under proper diet, change of air, and the improvement consequent upon these measures in the child, the tendency for these nerve explosions lessens and gradually disappears.

The reason for these phenomena is very evident. The nervous system of the rachitic child is in a condition of unstable equilibrium. Toxins absorbed from the bowel are able to produce marked changes in the joints, spleen, liver, and other organs. It is therefore not surprising that they also produce changes in a delicate organ such as the brain, and leave it in so hyperexcitable a condition that it is ready to explode, as it were, under the smallest irritation or provocation.

It is quite possible to see a rickety child, in the throes of convulsions, calm down and change, as in a moment, after the bowels have been well relieved by a dose of calomel; and, in the same manner, the restlessness at night is often better relieved by this drug than by the use of sedatives such as chloral or the bromides.

A CONTRAST.

A mother brought her youngest child for medical advice; and, as the **eldest** child was with her at the same time, it was instructive to examine both children for the purpose of comparison.

The sick child, aged 4 years, had marked rickets: beaded ribs, enlarged radial and tibial epiphyses, enlargement of the liver and spleen, and protuberant abdomen. No history of syphilis could be obtained. It had been carelessly fed, badly clad, and lived in a small cottage in a neighbouring village.

The other child, aged 7 years, was a fine healthy specimen of humanity. It had been breast-fed by the mother, and was well cared for. During the past five years, however, the father had given way to **drink**, and the purse and larder often remained empty: the children had therefore been fed on insufficient or improper food, causing rickets to develop in the case of the youngest child.

## C O N C L U S I O N .

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Rickets is a disease of domestication, and, in attempting to cure the disorder, it is first necessary to get back to nature - open-air life, free exercise of the body, and, for the infant, natural food from the maternal breast.

Wild animals and savage tribes do not suffer from rickets; and the children of Japan, who are breast-fed and live largely out of doors, seldom contract the disease. But, in zoological gardens, rickets becomes a constant pest, and wild animals - captured young and brought up in captivity - readily fall victims to the disorder.

When man departs from a natural state of existence, he no longer lives in the open air or hunts for his food, and the freedom of his limbs is hampered by unsuitable clothing. Civilisation has caused him to become domesticated, and, though it may introduce more comfortable conditions into his life, it exacts penalties in other directions, forcing him to live in an unnatural environment, which curtails his activities and produces artificial elements, - so that the normal functions suffer from disuse and tend to disappear. In this way such diseases as rickets arise amongst communities, and spread rapidly in all directions. The cure is a return to nature, as far as civilisation will permit, and an abandonment of all the artificial substitutes for healthy outdoor life and natural feeding. The simple life for man and woman, and the newborn child as well, is the real cure for rickets.

The strain and stress of modern life works against the adoption of so easy a cure; but, in his daily round, the medical man must endeavour to combat antagonistic elements and point out, to all entrusted to his care, the advantages, for themselves and future generations, of proper attention to the rules of ordinary hygiene. Particularly must he concentrate his attentions on the mother and the newborn child.

Of late years, the general practitioner has cavilled at the evils of competition and the loss of income, and at the same time a lowering of his professional position as friend and adviser of the family, as compared with bygone years. In the future, he may regain much that has been lost, and this by educating parents to appreciate the need of proper attention to their own health, as well as that of the child, as they will then place more value in his expert advice. The baby reigns supreme in the home, and it is by its careful upbringing and training, throughout its early life and childhood, that the medical practitioner makes for himself an honoured and respected position in the household.

The mother's welfare during pregnancy, her diet, mode of life, exercise, and so forth, all need careful consideration, - so that every means is taken to enable her to have a healthy child. Her breasts must be



inspected, and the physiological reasons for the necessity of maternal feeding of the child thoroughly explained to her, and in a simple non-technical language.

If artificial feeding is inevitable, the mother should have supreme control of the foods required by the infant; and the physician must instruct her in the best methods for modifying the milk, and making whey, soups, and gruels. Indeed, the family doctor should have some acquaintance with the handling of the saucepan, as well as the scalpel.

The mother should never be left to rely upon the advice given by manufacturers on the labels surrounding the tins of patent foods, nor should she be allowed to be tempted by the offers of generous supplies of free samples from the makers. Bread, barley, and oatmeal are all sufficient to supply the necessary gruels or jellies for the infant; and these can always be prepared at home. The dried milks and patent foods, which often crowd the nursery table alongside gripe-water and other <sup>drugs</sup> ~~mechanical~~ compounds, required to soothe the pains and colics engendered by faulty feeding, should be banished from the home. Clean milk and cleanly utensils are alone needed in the preparation of the infant's diet. If dairies were under proper supervision and control, parents might not be so ready to resort to the use of sterilised and dessicated milks and proprietary foods, and the need for these articles would greatly disappear. It would also be of considerable advantage if the sale of patent foods could be restricted by law, and their use prohibited without the advice of a medical practitioner.

In the matter of the abuse of patent foods, we of the medical profession are not altogether qualified to throw stones; it is necessary first of all that we put our own house in order. Indeed, it is a far too frequent practice for medical men to rear their own infants on various patent foods, and thus set a bad example in their immediate district: for the mothers, when they learn that the child of their own medical attendant is ~~being~~ <sup>being</sup> reared in this fashion, conclude that its management is the result of years of practical experience, and forthwith adopt similar methods for their own family. Medical men ought also to be more chary in prescribing proprietary foods in haphazard fashion; and the habit of chopping and changing from one patent food to another, because an infant does not thrive on a certain milk mixture, is a practice both unscientific and reprehensible, irritating to the parent, bad for the child, and unworthy of the dignity of the profession. We must practise what we preach, if we wish to encourage mothers to persist in breastfeeding, or to rear their infants on careful modifications of cow's milk without resort to the unnecessary addition of carbohydrate foods.

With a supply of clean milk at hand, the practitioner can direct the preparation of the food mixtures, and study the child's gradual advance in development, watching it safely pass the normal milestones; and, if

dyspepsias or signs of early rickets appear, his treatment can be prompt, and therefore doubly effectual. In this way, the medical man safeguards the child from the diseases of early life, and becomes the trusty friend and adviser of the families under his care; and, as parents learn to appreciate the value of his instruction and advice, and, year by year, see growing up around them healthy infants and sturdy children, they may not appreciate his services only in an ordinary commercial spirit.

The proper care of the mother and child has a still greater outlook, and one that is national in its importance. By a systematic instruction of women inspectors and medical men, the causes of infantile mortality can be attacked, and many valuable lives saved and trained up to robust manhood. It may be a matter of many years, a slow fight against uneducated, ignorant, and careless people, but, with united effort, success should be the final result. In this fashion tropical diseases are being stamped out; and, by education, organisation, and efficient inspection, rickets ought to be prevented or checked in its early stages, - though it may not completely disappear from this country, if climate has also to be reckoned with as a factor in the production of the disease. Nevertheless, the appalling number of cases present in all big cities ought to be materially reduced, - so that gradually a hardier race of children may be born, who will become immune to the disease, or able to resist more strongly its attacks on their nutrition and metabolism.

Mothers must be educated to recognise the serious responsibility of the duties owing to their children, and must receive help and practical advice from trained Lady Inspectors working under medical and municipal control. Breast-feeding must be the rule, and not the exception.

In districts with a large population of the poorer class, milk must be obtained from a certified depot or consultation, at which all young physicians should be able to receive special post-graduate training, where they should be entrusted with the duty of watching the infants week by week, and, at stated intervals, be held responsible for taking careful record of their weight and physical development; and, as occasion should arise, they are in a position to treat minor ailments and instruct the mothers in the general principles of infantile hygiene.

Milk depôts should become recognised institutions in every village and town, made, if possible, self-supporting, and controlled by medical men. They would serve as educational centres to young practitioners, who would derive great benefit from attendance if they could study the development and methods of feeding infants at the depot in the locality in which they first commence private practice. If a system on these lines could be followed out, there would soon be less need for books on Infant Feeding, and medical men would gain wider experience of the management of infants during the first two years of life.

At the Conference on Infantile Mortality (June, 1906), Dr. <sup>Sykes</sup> ~~Niven~~ declared that an Imperial race cannot be reared on the bottle; and this affirmation recalls to mind Lord Roseberry's famous declaration that an Imperial race cannot be reared in the slums of a city.

In the years preceding the decline of the Roman Empire, Favorinus - a philosopher - cried out against the unnatural nourishment of infants with degenerate and foreign milk; he foresaw the peril to the State, and demanded that the babes of Rome should not be nursed by women who poisoned their lives and strength with alcohol.

In modern days, a prophet is needed to make the nation realise the risks of artificial feeding with cow's milk, and the physical deterioration and degeneracy that it will produce in future generations. Mothers have reared the Imperial races of the past; and it is to them we look for the Imperial races of the future.

By his wonderful organisation and training, at the Tarnier clinique, Professor Budin is reported to have saved a battalion of infants for France. In these days, when phantom army corps only appear on paper evolved in the study of the Secretary for War, it behoves us to try and settle the army problem by studying the greater problem of infantile mortality, and endeavour to produce from the slums battalions of children, physically fit, ready, and able in later life to fight the battles of their country. Every infant carefully reared in the first two years of life would be a gain, an Imperial asset, and a national achievement.

"A little one shall become a thousand,  
and a small one a strong nation" (Isiah, lx, 22).

Every year, at a summer camp at Lwasa, the writer has the opportunity of inspecting over a thousand of boys from the lowest slums of Liverpool. He has ascertained, by careful weighing and measurement, that, in physique, they are below the standard of the average schoolboy, and that deformities of the chest are very common. But, even now, many could be turned into good soldiers, and, if they could be better cared for during infancy and watched through their early years of life, they could be made the raw material from which could be fashioned the finest soldiers in the world.

By studying the problems of infant mortality and infant feeding, we may finally discover the successful treatment of so so widespread a disease as rickets, and be able to adopt satisfactory measures to prevent its recurrence. The fight against rickets will be stubborn and protracted; but, with proper organisation and concentration of all forces of attack, the final issue should not remain in doubt. The practitioner who works quietly at home, in village and in hamlet, the busy physician in the crowded slums, each must play his part in the attempt to exterminate rickets from the infantile population. Further aid must be given by the State, by municipalities, and district councils, by inspectors, and willing bands of workers who can go from house to house seeking out the causes and remedying the defects of ignorance, poverty, overfeeding, and overindulgence. The mothers of



the rich, by force of good example, must help to educate their poorer sisters, until all women for the good of humanity loyally strive to nurse their infants at the breast; and the day will come when the sight of a child fed upon the bottle casts a slur upon the household that permits so unnatural a deed. Here lies a great field for the woman of the future; the reformer and the enthusiast suffragist in these matters have urgent problems waiting for the help of their voices and their hands.

The pathologist may in time supply for us an explanation of the true cause of rickets, and the physician discover some specific remedy able with certainty to cure the disease; but, in the meantime, medical men and mothers must unite together to check the spread of rickets, and strive to stamp out such a pest before it debilitates and cripples the development of the growing child.

No great glory will accrue to the worker in this field; his statue will not be found in the market place; but posterity will acclaim with thankfulness his devotion to the task of benefiting his fellowmen, and his memorial will be more lasting than brass.

The medical man is impotent, and can do but little lasting good without the help of every mother; they must be the van of the forces, gathered together to stave off the attacks of rachitic disease, or to prevent its further occurrence. Universal breast-feeding is the greatest of all prophylactic remedies against rickets; and, until this method is practised, nothing else is able to produce permanent results.

Napoleon the First, that great organiser and conqueror of nations, recognised the value of maternal care; and the true treatment of rickets and of many infantile problems lies in the words of one of his aphorisms, which says that:

"The future destiny of the child is  
always the work of the mother!"

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T H E      E N D .

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